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FOURTH WORLD FORESTRY CONGRESS

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PROGRAM

OF THE FOURTH WORLD FORESTRY CONGRESS

The role and place of forested areas in the general land economy and economic development of a country

1. The Present Status of Forest Protection and Forest Management in the World

Progress made since the Third World Forestry Congress

2. Protective Functions of the Forest

Determining the area to be reserved under vegetal cover for soil and water protection

(*a*) Forest influences (including forest grazing lands)

(*b*) Watersheds or catchment basins of valley development projects

(*c*) Reclamation of degraded soils, including deserts

(*d*) Shelterbelts

(*e*) Education in conservation; principles of soil and water conservation

3. Productive Functions of the Forest

Determining the area to be reserved under vegetal cover as a basis for industrialization and other economic or social purposes, and managing this area under proper methods

(*a*) Management for timber production and other forest products on lands under various categories of ownership and particularly integration of forest operations with the operations of forest industries

(*b*) Management of forest lands for grazing and their integration with other fodder resources

(*c*) Management of forest lands for wild life

(*d*) Management of forest lands for recreation

(*e*) Management of plantations outside the forest, in conjunction with agriculture or for special purposes (hedges, railway lands, roadside avenues, plantations of high productivity on agricultural lands, etc.)

4. Forest Products Utilization

Determining the most efficient methods of utilizing the products of the forest

(*a*) Extraction and transport:

(i) The status of forest workers

(ii) Mechanization of operations

(*b*) Utilization of hitherto little used species, including new techniques of seasoning and preservation

(*c*) Development of key-industries:

(i) Housing and new construction materials derived from wood

(ii) Pulp and paper

(*d*) Industries based on forest produce other than wood:

(i) Resins

(ii) Tans

(iii) Essential oils

(iv) Drugs, dyes, others

5. Tropical Forestry

(*a*) Methods of increasing growth and obtaining natural regeneration:

(i) Teak

(ii) Tropical rain forest

(iii) Mangrove

(iv) Bamboo

(v) Pine and other conifers

(vi) Other species

(*b*) Techniques of artificial regeneration and formation of plantations:

(i) Seed problems

(ii) Nursery practices

(iii) Methods of formation of plantations:
irrigated
non-irrigated
for special purposes (fuel, fodder, pulp, etc.)

(*c*) Desert control

(*d*) Shifting cultivation

(*e*) Inventories of tropical forests:

(i) Use of aerial photographs

(ii) Ground sampling

(iii) Growth determination and prediction

(*f*) Methods of research in silviculture — application of statistical design and analysis techniques

Unasylva

An International Review of Forestry and Forest Products

Vol. VIII, No. 3 **September 1954**

CONTENTS

Forests and Economic Development	99	Productive Functions of the Forest	116
Tropical Forestry	105	Forest Products Utilization	124
Protective Functions of the Forest	110	Forest Resources of the World	129

Cover design: *It was originally intended to organize an international poster competition in connection with the Fourth World Forestry Congress. For various reasons this project had, at this time, to be abandoned. A design meant for this competition is reproduced on the cover; it was drawn by M. Cassola of FAO's Documents Service after a sketch by G. G. Watterson of the Forestry Division. The photographs on pages 120 and 121 are also by a member of the Forestry Division, M. A. Huberman.*

A BIRD'S-EYE VIEW

A common complaint is that the increasing complexity of forestry leaves little opportunity for foresters — using the term in its widest possible sense — to keep abreast of the spate of literature in many languages on developments in their own or related fields of interest.

Appalled by the multitude of ideas and knowledge to consider in the limited time at his disposal, the forester wants on occasion to sit back and take a bird's-eye view of all the things that forestry has come to mean and what they portend. The papers listed above, read against the background of the results of the 1953 world inventory of forest resources, are intended to help him do so.

Written by staff members of the Forestry Division of FAO as a contribution to the Fourth World Forestry Congress being organized by India for next December, the papers are meant as broad surveys to set the stage for the discussions on the main topics of the Congress program. They try to offer ideas on some crucial points worthy of detailed debate. They do not propound dogmas — to which foresters are notoriously allergic — and if, as any glance at the proceedings of the three previous World Forestry Congresses may reveal, they do not say anything very new, they try at least to show the changing thinking of the world against which forestry must be adjudged.

World Forestry Congresses provide excellent opportunities for sharing ideas and giving stimulus to a wider use of knowledge. They also afford opportunities for technical men to highlight three or four outstanding problems on which FAO and its Member Governments should concentrate attention.

International organizations are mechanisms created by nations to serve their own ends, and the machinery that FAO represents now makes it possible to provide expert consideration and action on practically any problem of importance falling within the competence of the Organization. The Organization's program is approved and authorized by governmental representatives sitting as the Conference or Council of FAO. These representatives depend for advice on technical experts.

The Fourth World Forestry Congress is an occasion when such experts from many countries can concert and voice this advice.

Messages to the FOURTH WORLD FORESTRY CONGRESS from...

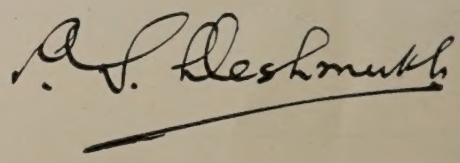
The Minister for Agriculture, India

In the forests of the Indian peninsula we find a fair reflection of the vegetation of the entire globe. Few countries therefore can vie with India in providing a venue for discussions on both tropical and temperate forestry. India enjoys the distinction of having been the first country to enunciate its forest policy way back in the nineties of the last century. The progressive realization of the importance of forests in the economic and the physical field, and the revolutionary changes which had taken place in the political field during the interval which had elapsed led, however, to a re-enunciation of the National Forest Policy in 1952.

The new policy takes into account the relentless pressure on forests to meet the needs of an ever-increasing population for food, fuel and fodder. No longer are forests to be regarded as an inexhaustible reserve for the extension of agriculture in quest of food. The intrinsic right of forests to occupy land permanently for their protective and productive functions has been accorded special recognition in our national economy. This has been done, I am happy to record, with a singular unanimity of opinion of men who matter.

As regards forest management on an international scale, the basis on which co-operation is to be sought must needs be regional rather than global. Countries with common problems would naturally evolve a common program requiring for its execution a common effort. Only the fundamental policies of various regions lend themselves to an integration on a global basis.

I take this opportunity of wishing God-speed to the deliberations of the forthcoming Congress. I sincerely trust that it will provide a forum for the exchange of experience, an opportunity for the provocation of thought and engender an *esprit de corps* among the foresters of the world to whom I extend a cordial invitation to this ancient land — the land of Buddha and Gandhi.



and...

The Director-General of FAO

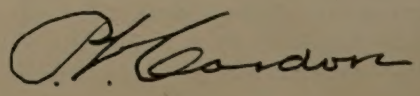
The World Forestry Congress, which is to open in Dehra Dun on 11 December, will be the second such congress to be sponsored by FAO. While the entire honor and responsibility of organizing this gathering devolves on India, we in FAO are of course giving our fullest support.

The Congress will have before it the broad findings of FAO's latest inquiry into the forest resources of the world. I think these findings mark a very significant step forward in world forestry. But I would like to draw attention to the small proportion of the world's forests "in use" and the even smaller proportion under " management, " as revealed by this survey. This poses a clear challenge to foresters and governments in view of the aims of FAO's Constitution and the " Principles of Forest Policy " set out by the Sixth Session of the Conference of FAO in 1951.

One more point to which I want to draw attention is housing. Freedom from want — our objective — implies adequate shelter. It has been said that the quality of a man's housing probably does more than any other single element of his living standards to determine his sense of citizenship and community. I think, therefore, that the needs of the world for housing in various forms offer another great challenge to foresters and to forest products industries.

What do I expect from the Fourth World Forestry Congress? Not directives which only Governments can give, but instructive information and advice on which those directives can be based and, following which, I can see that our abilities for service can be made most effective.

If we can recognize the inviting horizons ahead and be advised how we can move towards them in helpful association with each other, I am convinced we can realize our ambitions. In so doing we can experience the gratification of achievement which, after all, is perhaps one of the highest forms of compensation to be derived from any endeavor.



Forests and Economic Development

The Role and Place of Forested Areas in the General Land Economy and Economic Development of a Country

OVER the past 150 years the world has evolved at a more rapid pace than ever previously, due to the power placed in man's hands by science and technology. New knowledge and achievements have in fact enabled man to alter his physical environment, for better or worse, within a space of time relatively short compared with the slow aeons of change effected by earlier civilizations.

It is true that some parts of the world have superficially still been little touched by this evolution which in relation to the whole course of human affairs, might justifiably be termed a revolution. But since ever wider trade and spread of ideas are characteristics of today, all areas will surely be affected sooner or later, although perhaps in different ways, by the many physical, social and political sequels which circumstances now bring in train.

Impact on land use

The slow evolution of early centuries led to patterns of land use that were sometimes durable but more frequently transitory. Moreover, developments did not work in one direction only; for instance, in time of peace or population growth, there was more rapid clearing of land for cultivation or grazing, while in time of protracted war, which was sometimes accompanied by the downfall of entire civilizations, the forest often regained all or part of its lost terrain. The outcome differed, too, with the region, the climate, and the type of civilization. In many parts of the world, the natural severity of the climate prevented the forest or other vegetation types from regaining a hold on cleared land where plant cover is normally vital to anchor any soil or conserve its fertility; natural or induced grasslands were overgrazed and indiscriminately burned, and turned into desert. Elsewhere, for various reasons, and not least because populations remained small, the natural plant cover retained its entity.

Throughout the history of this long evolution, man through his method of living has constantly interfered to upset any possibility of an equilibrium being established between land under permanent cultivation or cultivated in rotation, and land covered with forest or natural vegetation.

The greater speed of events today has already had, and will doubtless continue to have, a similar impact, but the results become evident more rapidly and violently. Therefore, man must control misuse if he has any desire to obviate the sudden onset of damage on the scale that in the past took many centuries to bring about. The Fourth World Forestry Congress can, therefore, with advantage turn the light of modern knowledge and experience on the whole subject of forests and forest ranges, their distribution, their effects on the physical environment, their utility values, and the balance between land dedicated to forests and that required for intensive use, against the background of expanding national economies.

Growth of world population

It may be opportune here to run over the factors that have particularly affected any balance between the forest, in the broadest sense of the word, and cultivated land.

The first is obviously the pressure of growing world population. This pressure may be assuaged by finding new land for cultivation to provide food supplies for the increasing number of mouths. Land cultivated in former times and then abandoned and become degraded, can in some cases be rehabilitated though the cost may be high; other land can be rendered fertile by irrigation; but clearly it is virgin or scarcely touched forest that greedy eyes look to for more soil for cultivation, and usually where the quality of the forest crop demonstrates the goodness of the land.

At the same time the larger world population, with aspirations to higher standards of living which in turn rest on the development of national economies, brings in train a greater demand for wood as a raw material than ever before. These increased requirements could, it has been estimated, well be satisfied in the aggregate by the present areas under forest, provided the growing stock were properly managed and utilized, which is often far from the case. Any reduction of presently forested areas on a large scale for agricultural uses might jeopardize timber supplies and the pinch would be felt most by just those areas where forest resources were most meager.

Drift to the cities

A second factor to come to mind is the shift in relative numbers between people living in towns and the country. This shift, which inevitably accompanies industrialization, is itself a sign of economic and social development. It does not necessarily, at least in countries with a high birth rate, lead to a decline in the rural population, but as the numbers of non-producers, agriculturally speaking, in urban areas grow, the country population must produce more to support them. This increased production can be obtained by bringing into cultivation relatively less productive land still under natural cover; generally countries pass quickly this stage of economic and social development and the emphasis

then is rather on intensive high-yield farming of the better soils and abandonment of marginal lands, which then revert to natural vegetation.

At first glance, this would seem to favor the forest but the exodus from the countryside can in other respects adversely affect the general economy and forestry too.

Communications

A third factor variously affecting the forest is the development of communications. In the first place ease of communication accelerates the drift to the towns alluded to above. Looked at from another angle, it facilitates settlement in areas as yet undeveloped. Colonization of this sort will doubtless eat into nearby forests but may, on the other hand, permit the working of stands hitherto of only theoretical value, because the long-distance haul of timber from them just did not pay.

It is generally enough recognized that overseas transport of wood in the round from one continent to another is uneconomic except in the case of very highly-prized timbers. However, the improvement of communications between countries of one region does foster some specialization in forest production in countries where climatic conditions are especially favorable to the growing of particular products. Again, the expansion of roads, railways or water routes makes it cheaper to supply rural populations with alternate fuels to wood, particularly mineral fuels, and this affects the categories of wood products required of the forest. A final example is that better communications under certain circumstances, facilitate the establishment of complex forest industries that must draw on extensive areas of forest for their supplies. Under different circumstances, however, notably where there is considerable fragmentation of forest holdings, the effect may be a multiplicity of small industries, inefficient and wasteful of raw material.

Improvement of farming techniques

Better farming methods can also have various and even entirely opposing effects upon the forest. First, land may be put to the plough that hitherto has been regarded as best maintained under natural cover, perhaps because the slope was too steep or the soil too poor. Thus improvement in farming techniques or rather in soil conservation practices and in maintenance of soil fertility, may lead to a definite reduction in land under forest. On the other hand improved techniques sometimes permit a considerable increase in productivity of land already under cultivation, which results in turn in the abandonment of marginal land and the recapture of such land by forest. Coupled with a decline in rural manpower and the frequent trend toward specialized farming, this factor may also cause a complete changeover in the type of agriculture practiced in a given region; lack of manpower, for instance, may foster concentration on livestock farming where hitherto there had been mixed farming; then forest grazing may need to play an important part. In other instances, on the contrary, mixed farming may replace a purely pastoral way of life which is outmoded, and this may greatly relieve the pressure of livestock on the forest and forest-range zones, enabling headway to be made with reforestation or at least the introduction of efficient range management on areas depleted after long misuse.

Development of industries

Allusion has already been made to the impact of economic development in general, and industrial development in particular, on wood consumption. But industrial growth raises other forestry problems which must be considered. For instance, large industrialized cities require regular and ample supplies of good clean water, both for human consumption and industrial use. Much of this must be supplied by reservoirs, the value of which will rapidly diminish unless silting is effectively controlled. This all points to the need for intelligent management of the upper watersheds that are generally forest range zones. Often these zones are already degraded owing to excessive exploitation of trees or overgrazing and need to be rehabilitated, which in turn means, if not closure and reforestation, at least better utilization of the forest and range resources of the whole basins. Then we may consider that cities, as they grow larger, require "green belts" around or even within their boundaries to provide healthy surroundings and recreational facilities; all modern town planning takes this into account.

This leads to another reflection. The urge towards industrial development leads to search for raw materials on which this can be based. Prospecting for minerals, ores and oil goes on everywhere, but many countries will find that they are poor in such resources. The growing of industrial crops is often limited by land scarcity, and has frequently to compete with regular farming. In any case, reliance on a few industrial crops, vulnerable to fluctuations on world markets, is dangerous to the national economy. This being so, some underdeveloped countries well endowed with forests might give more attention to basing their industrial development on the utilization of wood, choosing for pattern perhaps the prosperous countries of northern Europe. Remember that in some parts of the Far East where steel is scarce, there is serious contemplation of the idea of substituting wood in its place for many uses.

Wood in fact may be regarded in many senses as a new raw material with unlimited potentialities for building up both primary and secondary industries – always provided adequate areas are kept under forest in any given country and properly managed to assure continuous supplies of raw materials.

Advances in forestry practices

Among the factors of the "revolution" of these past 150 years that must directly affect the future of our forests, obviously progress in the techniques and art of forestry itself must not be overlooked. Forest research has naturally aimed at producing better quality and quantity of growing stock and yield; presuming that the methods found by research and perfected by experience are of general application, this should mean that a reduced forest area can meet increasing needs. For many reasons this has not happened yet and there is a long way to go and many conditions still to be fulfilled before scientific forestry, or agriculture for that matter, can assure that any particular plot of land can be used to the maximum of its capability on a sustained-yield basis.

Nevertheless, there have been some achievements in silviculture that really seem to open new vistas for forest policy.

The most striking perhaps has been the use of certain species, often strictly local in their origin, which when introduced to other similar ecological environments but far from their natural habitat, proved to be exceptionally rapid growing and of high economic value. Examples are *Pinus radiata* and certain other softwood species of the interior and west coast of North America, some eucalypts, acacias, and poplars. Sometimes the introduction of such species has given a new look to forest policy. In their natural habitats these species have been neglected or valued only for protection or amenity, but in their new range much effort has been lavished on them. They have even been introduced as speculative ventures; planted on good soils, the profit they can yield where wood is otherwise scarce, has enabled them to compete to advantage with agricultural crops so that sometimes they are grown on soils that perhaps would better have been used for farming.

Mention of such species raises another point in regard to allocating land between farm and forest. In many countries farm and forest, or at least trees, have long been complementary, in the main because of the protection against erosion or parching winds that they afford rather than for any value of their products. Windbreaks or shelter belts of trees are far from being of negligible importance today; on the contrary, research into their value and sometimes grandiose projects on the ground have tended to assume more and more prominence; but the farmer, even the small farmer, is also today becoming increasingly interested in having on his farm a small woodlot, even single trees or borders, that in a few years can bring in a useful income. This trend enables the undoubted benefits accruing from farm woodlands to be received by farmers in areas or communities where no form of communal forest is available. At the same time in many countries the state authorities have undertaken to provide plantations for communities where supplies of wood are meager or otherwise difficult to procure. Just as a well managed communal forest can provide a community with means of augmenting its income and occasional funds for special expensive works such as roads and piped water supplies, so the farmer may well consider his small woodlot or group of trees as a savings account on which to draw when he wants to make improvements to his land or home. The farm woodlot to this extent may solve in part the problem of agricultural credit. Remember also that some trees, aside from the wood they produce, can supply the farm with a useful feed supplement for man and beast in the form of fruits or leaves. Even full-scale plantations of certain species that yield marketable products on a short rotation, need only interfere with cultivation for a few years since grazing and even crops can be had under the tree cover during most of the rotation.

Rapid-growth species may also be planted on an extensive scale to feed a particular industry or factory, or to meet a particular purpose. Industries using wood for fuel and power generation often find it more convenient to establish nearby plantations of rapid-growth species than to count on supplies from scattered natural forests often far removed and requiring complicated extraction schedules if a sustained-yield is to be obtained.

New wood-use possibilities

The last factor in this "revolution," or rather the last we shall deal with here because our list is not exhaustive, is the new uses for wood which have come about. This is a theme much talked of and one discussed at the Third World Forestry Congress in a way that led to some confused thinking. The utilization of wood broken down into its constituent elements, to a degree depending on the particular industry, is steadily growing as compared with traditional methods of using this raw material in solid form. Industries are increasingly able to use more various categories of wood and "wood-waste" formerly abandoned or burned. The result is not only a much fuller and more efficient utilization of the basic raw material but also a change in cutting and extraction practices and in forest management. This may be of even greater significance for tropical forests than for forests of temperate zones, as may be brought out during the discussions on tropical forestry at the Fourth World Forestry Congress.

Further, this sort of development obviously conduces to the creation of big groupings (*unidades*) of wood-using industries; the growing strength of such enterprises in many countries is itself an indication of the great changes that have occurred in the last half-century in the approach to the utilization of the raw material, wood. It is plain, however, that as such industrial empires are created, the forests must be perpetuated to supply their requirements. This requires not just sound working plans and efficient management methods, but may also need legislation and regulations at the governmental level. In short, it takes deliberate action to bring about integration between the forest and industries.

Principles for the Framing of Forest Policy

Confronted with so many factors to take into account, each with some different and maybe contradictory bearing on the use of land for forest, are there any guiding principles for the framing of forest policy?

It appears to have been generally accepted that there are, considering that the member countries of FAO, working through the Sixth Session of the Conference of FAO in 1951, adopted a set of "Principles of Forest Policy" which had been formulated in compliance with a recommendation of the Third World Forestry Congress, meeting at Helsinki in 1949.

Soil and water conservation

These principles are disarmingly simple yet truly comprehensive, but they concern only a particular aspect of the broader picture of land use in general. We want a formula for basic principles of overall soil and water conservation and use, remembering that the soil is the prime resource of the world as we know it. We endanger or destroy the soil at our peril; any sound policy of land use must be synonymous with soil conservation and be in conformity with basic principles of soil use.

Foresters alone cannot be expected to formulate such principles. Forestry, despite the many utility values and services of the forest, is only one form of land use; but foresters should certainly have a say in framing

principles of this kind in view of the vital contribution that forested areas and forest-range zones make to soil conservation, the halting of accelerated erosion, regulation of streamflow and the production of the water supplies necessary today to industry and cities. How much more readily would forest policy receive a hearing from governments if it were clearly grounded on universal principles of land use and conservation subscribed to unanimously by the governments themselves. Some governments have already declared themselves to be of this way of thinking, and the urgency of the matter may perhaps be summed up by quoting from a recent article in *Unasylva:**

> "Our present civilization provides man with so much more powerful means than in the past of affecting mankind itself and the natural environment — so powerful, in fact, as to make it possible to remodel nature — that it can either hasten soil degradation beyond all previous measure or end it."

The regional approach to forest policy

If the basic "principles of forest policy" of FAO seem too broad to serve as an effective model, there are many ways of spelling them out to make a more precise guide to individual countries.

First, there is the regional approach. The problems inherent in forest conservation and use and the development of forest industries differ in their details from one part of the world to another.

Europe and North America have to solve their problems of increasing the productivity of the forest and of industry under comparatively easy conditions; their forests are relatively homogeneous, research is well-organized and widespread, and their professional foresters have a long background of experience. But peculiar difficulties are often presented by the fragmentation of forest ownership, by varied systems of land tenure, intense competition for land, and the dispersal of wood-using industries.

The main problems in Latin America are bringing vast extents of practically still virgin forest under management, in conjunction with land settlement and development; the expansion of transport; the development of domestic and foreign markets for forest products; the establishment of new forest industries; creating local supplies for urban areas; and rehabilitation of eroded land. The difficulties that stand in the way are many, not least because comprehension of forest policy is mostly in its infancy.

In the Near East the urgent problem is to take care of and improve the areas of forest range that have received such harsh treatment in the past. At the same time, local wood supplies must be provided by forming small plantations and woodlots on farms or by creating larger irrigated plantations in suitable locations. Here the close tie between forest policy and general land use policy is perhaps more striking than elsewhere.

Then in the Far East there is a medley of problems and difficulties to be faced. Conditions vary from arid to the humid tropics, from continental to oceanic climates; in some countries dense overpopulation, in others freedom to move reflected in the different character of the peoples; generally a high state of development of silviculture but little attention hitherto paid to utilization and industry.

Some real progress has been made in the past few years in shaping what might be called regional forest policies. Through the medium of FAO and its European Forestry Commission, and basing their assessment of probable future trends on an analytical survey entitled "European Timber Trends and Prospects," European countries have tried to take a composite view of policy for Europe. In Africa and Asia and Latin America more countries have defined their national policies in accord with principles applicable to regions as a whole. However, the data on which true regional policies could be established, as has been attempted in Europe, are in general lacking; for instance true figures of forest areas, their useful growing stock and productive capacity, and of how forest products are actually used and consumed. In time, however, there will be progress in individual countries and, through mutual co-operation and exchange of views, there will come about a gradual clarification of regional forest policy, transcending present political issues.

The approach by subject

There is another way of approaching the determination of forest policy and that is to treat each aspect separately. For instance there are several clearly defined subject matters of general policy interest such as grazing in the forest or on forest ranges; forest fires; or the wider development of pulp and paper industries throughout the world. Perhaps decisions and broad policy lines should be arrived at first in regard to each such topic, and the several results then be co-ordinated into one world forest policy, in the same way as forest policies should be brought into conformity with broad principles of soil and water use and conservation. Before they can be applicable to individual countries, such subject matter policies must still be adapted region-wise so, in the final analysis, a combined regional and subject-by-subject approach seems to be the most effective way of proceeding.

Importance of international co-operation

It will certainly be said that to talk of regional and world forest policies at this stage is like trying to put up the roof before you have built the foundations and the walls: first each country must define its own national policy in accordance with its respective physical, economic and social conditions. This objection is perfectly valid, even if we point out that forests and climates do not respect political boundaries. Of course, international action cannot usurp or substitute each government's responsibility for defining and implementing its own policy on the basis of the findings of its own experts. But this is not the same as saying that international action in this field is of little or no value.

To adopt this attitude shows little understanding of the very great influence exerted on, or rather the unique service rendered to, the framing of forest policies in even the most advanced countries by the international exchange of information, ideas and experts.

There have always been some influential minds in every country that have understood the importance of

* *Unasylva*, Vol. VII, No. 4, December 1953. "Soil Conservation," by Saleh-ud-din Ahmad.

the forest to the national economy and in the conservation of soil and water. There have been local authorities or national governments that have heeded these individuals and taken steps to halt dangerous exploitation of natural resources or to direct forest production along lines serving the general interests of the country. But forest policies, as understood today, based on a scientific conception of silviculture and forest management and not on either purely commercial considerations (which have sometimes led to forest despoliation) or conservation strictly interpreted (which has sometimes meant jealously preserving forest resources without putting them to any practical use), evolved at approximately the same time in several European countries. Through the exchange of ideas among these countries' experts, policies were altered and refined: then the concept spread at varying speeds throughout the world through example and travel.

Ever since deliberate forest policies in the modern sense were first propounded, international exchanges have played a prominent part in their development. This will continue, the more so that there are international agencies to speed the work. FAO is now an organization used confidently as an instrument by 71 sovereign governments. In the special field of forestry there is every advantage for FAO to sponsor international congresses such as the Fourth World Forestry Congress which brings together individual experts from many countries to voice their experience and opinions and give technical advice on the problems that exercise governments at the policy-making level.

Function of world congresses

Like national forest policy, regional and world forest policies can be based only on the conclusions of experience which must cover many fields, so diversified that no single specialist can claim to be able alone to appraise the exact impact on policy of his findings. Hence the need for occasional interchanges of views on a worldwide scale from the angle of separate disciplines and a variety of local conditions.

This sort of exchange of ideas, however, can have little practical value unless it is orientated directly towards a solution of specific problems. The substance of the earlier part of this paper is that we are at present witnessing a "revolution" in the world's development, and we have before us one big forestry problem, namely to decide how much land should be permanently dedicated to forests, using the term in its broadest sense, and knowing that a prerequisite to the answer is that the land should be managed so as to furnish benefits, services and products to the maximum as may best suit the needs of each country. Also that the productivity of the forest should be used to capacity by continually developing improved methods of utilization and efficient forest industries.

Program of the Fourth World Forestry Congress

Even if the organizers of the Fourth World Forestry Congress have assembled an agenda along what appear to be, and in fact are, classical lines, it should be remembered that the idea is to discuss each topic from a particular standpoint, so as to show as far as possible the bearing of any one problem on the general theme of the Congress, namely, determining the area to be reserved under vegetal cover.

We repeat that we are using the term "forest" in its broadest sense to include, in addition to areas regarded by all as forest lands, related lands where trees may be sparse or altogether absent, or the stands of relatively poor quality or even scarce and irregular, but which can be used extensively for grazing by livestock or wild animals, and sometimes for various types of shifting cultivation. Such lands complement the fully wooded areas, and so affect their treatment, in that they afford protection against abnormal erosion and, especially where they constitute watershed areas, act as a regulating factor for water supplies. In some cases, all or part of such areas are legally incorporated into the public forest lands; in other instances, the forest boundaries (where these have actually been fixed, which is usually the exception) deliberately exclude poor or sparsely stocked areas. In either case, because of their interdependence with the true forest, the way in which they are treated is very important to foresters.

We must also take into account as "forest" those plantations which are commonly called "plantations outside the forest" and which also have a useful role to play in soil and water conservation and erosion control, as well in producing supplies of wood and sometimes fruit or fodder.

Protective functions of the forest: This topic has been included at the beginning of the program of the Congress and is to be treated from the point of view of the policy-maker having to assess the problems raised by the application of the national forest policy and the allocation of forest land in various parts of the country.

The importance of the protective functions of the forest has been explicitly recognized comparatively recently, although scientific research has been under way for over 100 years and is still being actively pursued. At the same time tremendous progress has been made in techniques of soil conservation, restoring soil fertility, and regulating streamflow by what we may call artificial protective methods, to differentiate them from those based on efficient use of natural vegetation. But the application of such artificial methods is limited by either physical or economic factors. What are these limitations? What exact function must the forest play in a national program of reclamation or conservation of lands bearing or suited to bearing forests; in maintaining and improving the productivity of all lands; and in providing adequate water supplies for industry, cities and rural communities? These are questions to which the Congress discussions on forest influences may perhaps be able to give specific answers.

Productive functions of the forest: A second point in the program relates to the productive functions of the forest seen from the same viewpoint. In the light of changing world conditions, how should one determine what lands should be kept under forest to supply a country's needs for forest products? Then secondly, how should such lands best be managed?

The first is certainly a difficult question to answer. Of course a simple classification of lands according to their forest-bearing capabilities may in itself prescribe the limits, in that it is found that there just is not enough suitable land to fill all needs. However, usually one

must go further and endeavor to predict the long-term timber and forest product needs of the country which is a hazardous, even though necessary, occupation.

The only practical course is to be bold. Although we can only narrowly predict future needs, we can deduce likely trends and be prepared for eventualities. The general trends that will sooner or later affect all countries are industrial expansion; a parallel increase of total wood requirements; a reduction in demand for fuelwood; and a relative increase in the needs of pulp and paper industries.

Forest products utilization: Forestry is not merely a way of harvesting crops; it is an enterprise supplying raw materials to a wide range of primary and secondary industries that are an integral part of a country's economy. Therefore, the question arises how important should it be in the national economy.

It would be too easy to reply that this entirely depends on how much forest actually exists. But there are heavily forested countries where forest industries make little or no contribution to the economy; others where the recognized need to develop certain industries has led to the establishment of new plantations where forest was formerly non-existent. This, then, is not the right answer.

In order to reach a sound decision, many factors must be taken into account and these are set out in a later paper. But the Congress is urged to examine most carefully under this point, the prospects for profitable forestry opened by the latest advances in logging and conversion techniques, assuring a better integration of wood-based industries in the general economy of a country and offering prospects for great developments.

Tropical forestry: The last item on the program of the Congress relates to tropical forestry. The policy principles applicable to tropical forests are no different from those applicable to other kinds of forest. But the methods and techniques for fully applying these principles have not yet properly been worked out, except perhaps in exceptional cases of unmixed growing stocks. Technical problems of utilizing tropical forests arise, we know, mainly from their mixed character. There are many other problems — in inventorying, silviculture, management and exploitation — that must influence policy consideration of how best to promote the industrial and agricultural development of countries having tropical forests, and how to raise living standards. The Congress will be expected to indicate how best tropical forestry can serve economic development.

The goal before the Congress

The Congress has been set an ambitious goal — to decide the extent to which " forests " should contribute to the expanding economies of individual countries and of the world, in the light of progress made to date in knowledge of forest resources, in silviculture and management, in logging and utilization.

It would, of course, be ridiculous to expect the Congress to produce definite answers to all the problems which have been touched on in this paper; the Congress is only one phase of a continuous international effort to formulate reasonable forest policies. It will be followed by other meetings of individual experts or of governmental representatives. Nevertheless, the ideas put forward on this occasion will doubtless receive critical and helpful examination and will stimulate the thinking of all those responsible for forest policies. What the Member Governments of FAO can expect from the Congress is essentially guidance on desirable international action — not policy decisions but competent and considered advice on which forest policies can be founded.

What the Director-General of FAO expects is guidance as to the best means of co-ordinating international action — in research, technical activities and policy — so that the Organization can keep pace with the " revolution " in world conditions to which we alluded at the outset, and " forests " can suitably contribute to an expanding economy and the whole progress of mankind.

FORTHCOMING MEETINGS

- FAO's regional Forestry Commissions are expected to meet as follows in 1955: the third session of the *Asia-Pacific Forestry Commission* at Tokyo in April, the fifth session of the *Latin American Forestry Commission* probably in Venezuela in May or June, the first session of the *Near East Forestry Commission* early in the year, and the ninth session of the *European Forestry Commission* at Rome in October.

- The eighth session of the full *Conference of FAO*, the governing body of the Organization, is set for Rome in November 1955. The twelfth congress of the *International Union of Forest Research Organizations* is scheduled for 1956 in the United Kingdom.

Tropical Forestry

Some Aspects of Forest Problems Peculiar to the Tropics

THE Fourth World Forestry Congress will devote an important part of its discussions to tropical forestry, and will be probably the first truly world-wide forestry meeting to do so.

Why should tropical forestry be discussed as though it were a separate topic? Is it to be regarded as a separate science or merely as a special application to tropical conditions of the "forestry" that has hitherto been most highly developed in the temperate parts of the world? There has been much talk on this point which still continues, but the issue is more academic than practical. The basic principles of "forestry," whether relating purely to silviculture, policy or economics, are valid in all latitudes and for all work throughout the world. But admittedly the conditions in the tropics — physical, biological, social, economic and even political — and the ways and means of translating principles into practice are very different from elsewhere. It may be conceded, therefore, that tropical forestry, in the main, presents a series of special cases in each of the broad fields which together constitute what we call "forestry." This paper offers some premises in regard to such special cases as a basis for discussion.[1]

The tropical forest in the local economy

Correct appraisal of the forest's role in the economy of individual countries or sections of a country is needed the world over. In the tropics a proper assessment is of special importance because on it may hinge all efforts towards economic development.

To the north and south of the tropical zones lie countries where economic development is, to generalize very broadly, well advanced and perhaps has already taken its final shape. In some instances the forest serves its proper place, even though elsewhere it has been too much encroached upon. On the whole forestry is a matter of applying known practices and techniques to known conditions.

In the tropics, on the other hand, lie countries which for the most part are only on the verge of economic development — new countries, in an economic sense, where everything can be schemed in perspective. For the most part the climate, soil and vegetation are such that deliberate planning is necessary to assure the maintenance of a proper equilibrium between the natural conditions of a country and steady economic growth. But the problems to be faced in planning are novel and involved; particularly the forester is confronted by the difficulties arising from the mixed character of tropical forests and from the great lack of knowledge of the useful products that can be drawn from the forests.

In any planning for economic development, agricultural and industrial activities must be balanced. What makes the role of the forest so important in the tropics is that here, more than elsewhere, the forest is basic both to agriculture and industry. Therefore, it is necessary to decide:

1. the relative emphasis to be given to agricultural and industrial development;
2. the place of the forest (whether permanent or temporary) in relation to the picture of rural development and farming proper, keeping in mind not only soil conservation and land capability but also particular practices such as shifting cultivation;
3. the place of forest industries in the general industrial development. The forest, as a renewable natural resource, may on reflection prove of primary rather than secondary importance.

Before decisions can be made on these matters as a preliminary to full-scale planning, detailed area studies must be undertaken. And here we come to a first principle that must guide the forester in the tropics: *forestry in tropical areas must not be regarded only in the absolute.* Save in certain rich and densely populated areas, the possibilities for forestry must always be appraised against the local characteristics of soil, climate and vegetation, and against local customs, practices and rights of usage that are not abruptly to be changed or abolished. *They must, in fact, be reconciled with:*

(*a*) *the general agrarian structure, and a comprehensive program of soil conservation and sound land use;*

(*b*) *the overall economic development possibilities of the area, and a program of balanced agricultural and industrial expansion.*

Forest inventories

In speaking of a "program" we thereby postulate a thorough knowledge of all the local circumstances, which in turn means a prior resource survey. And in the tropics, a forest inventory is the most important part of any such survey. From our first principle, therefore, we infer that the basis of all planning must be the forest inventory. It is not possible in a paper of this sort to go into the technical details or special difficulties of making an inventory of tropical forests. These, it is hoped, will be treated in other papers presented to the Fourth World Forestry Congress. But we can say that such inventories are complicated matters which, whatever the degree of detail required,

[1] Special features of coniferous forests, pure stands or almost homogeneous types growing in tropical areas are outside the scope of this paper. The problems involved are less complex than in the case of mixed tropical forest and they have already been the subject of much study.

cannot be carried through without the active co-operation of foresters actually working in the forest. Whether it is for the purpose of quick surveys for delimiting areas of forest to be protected, or of detailed studies for drawing up individual working plans, aerial photography experts need to work in close collaboration not only with the men in the field carrying out ground sampling and mensuration, but also with the forest services invested with the responsibility of co-ordinating the various tasks involved and making the final analysis of the results.

Shifting cultivation

Before leaving this section on the fitting of forests into planning for economic development, some words should be said on a particular aspect, namely shifting cultivation.

In a predominantly agricultural economy, the next step after the resource survey and analysis of the results will be a land classification into three major types, whether or not any particular land was originally under forest:

1. lands to be permanently dedicated to forest, whether at present forested or to be restored to forest as the climax vegetation;
2. lands to be dedicated permanently to agriculture;
3. intermediate lands, suited to multiple use, and whose precise functions would be settled on economic grounds as the overall development plan was worked out. The allocation of such intermediary type lands is always a delicate matter, complicated in the tropics because of the common practice of shifting cultivation.

Some people regard shifting cultivation merely as a traditional form of forest use by the autochthonous population and a problem that the forester can be expected to solve either by total prohibition of the practice or by restricting it to specified areas. Others, on the contrary, only concerned with the agricultural aspects, wish to see the native farmers weaned from shifting cultivation to permanent settlement. The matter is far less simple and must be looked at against the background of the entire agrarian structure in a given tropical area.

Shifting cultivation, as traditionally practiced by native inhabitants before the arrival of settlers from other areas, for instance by the Britons in what is now England before the arrival of the Romans, is not particularly dangerous. In the wet tropics a state of equilibrium is commonly reached, first, because tillage is restricted to soils of suitable structure and chemical composition which, however, contrary to general belief, are limited in extent in forest zones and, second, because the forest clearing is part of a true crop rotation system which includes a forest fallow of sufficient duration to permit restoration of the tree cover and the regaining of soil fertility. Primitive communities who practiced shifting cultivation customarily set self-imposed rules:

(*a*) use of suitable soils which did not deteriorate too rapidly after having been cleared of cover;

(*b*) crop rotation, which did not leave the soil too long exposed and which included a sufficiently long forest fallow to permit both the restoration of the tree cover and of the humus;

(*c*) choice of an area where the climatic conditions made possible a rapid and dense regrowth of trees to form a stable forest canopy.

With the arrival of new settlers and increasing populations, this equilibrium was upset for various reasons — changes in the types of food crops grown, larger food requirements as living standards rose, the introduction of cash crops. It became necessary to produce more and, since the villager was not able to increase his yields, he had to enlarge the area that he cultivated.

First he tried to use more fully such suitable soils as were still available for shifting cultivation. But generally there was not enough such land which was not at the same time too far from the community center, so the alternative was to cultivate poorer soils or to return more frequently to the same areas and reduce the period of forest fallow.

The outcome in either case was gradual soil degradation, with a decrease in crop productivity, and because of the disappearance or impoverishment of the original type of forest cover, unfortunate direct or indirect effects on the forest.

Shifting cultivation may be said to become dangerous as soon as it loses its nomadic characteristics without any compensating features — when in fact it becomes nothing more than regular cultivation on forest soils.

To obviate the bad results of malpractices in shifting cultivation, two courses are necessary:

1. measures must be stipulated (change of cultivation methods, still utilizing shifting cultivation practices if need be) that will maintain or increase crop output without causing soil deterioration;
2. the reservation of minimum areas of high forest in any given locality where shifting cultivation is totally prohibited so as:

   (*a*) to effect soil conservation and maintain streamflow;

   (*b*) to meet local needs for timber and fuelwood and in other ways to provide for a balanced economy.

This oversimplified sketch of the problem of shifting cultivation is sufficient to indicate the solution to be sought and the forester's responsibility. Improvement of shifting cultivation practices must be based on planned use of soils and forests. It is thus contingent on forest inventories, and depends on local circumstances, the possibilities of introducing various agricultural and silvicultural techniques, and present or prospective social and political conditions.

Wherever shifting cultivation is practiced, forest policy cannot properly be formulated or implemented, either for protection or to promote development, without taking all the various factors involved into account. It is because of its bearing on our first principle of tropical forestry that the topic of shifting cultivation has been included in the program of the Fourth World Forestry Congress.

Management and treatment of the forest

Planning is not possible without some understanding of the relative value of the elements involved. In the tropics, with few exceptions (pure stands or forest types with few associated dominants) the present and even more so the future value of the forest capital is hard to assess. Any development scheme based on forestry, which must perforce be long-term, must therefore be drawn up on the forester's appraisal of the forest, how he wants to treat and manage it, and on his assessment of the type and quantities of products that he expects to obtain.

We may be sure that, except in the case of purely protective forest, no forester wants to leave the heterogeneous growing stock of tropical forests to nature. The complex composition of the stands and the poor quality of most of the timber make extraction and utilization difficult, both from the point of view of methods and economics. But the forester has to set the need to convert the forest against the danger that conversion may upset the particularly delicate ecological balance.

There is no intention of presenting here a thesis on tropical forestry, but some words would be in place on the schools of thought that have arisen in this field. Commercial exploitation of tropical forests has in general been restricted to a small number of merchantable species; foresters have tried to increase the proportion of these valuable species in the growing stock, either artificially or by improvement fellings, sometimes both together. To do so they devised and perfected a variety of methods.

Gradually the number of merchantable species accepted on international markets grew, domestic demand rose appreciably and wood-working industries able to absorb many more species of mixed forest types became established right in the zones of tropical forest. All this gave rise to the admirable concept of total utilization of tropical forests.

Although this was theoretically the goal, in practice total utilization remained impractical or prohibitively expensive, even with the help of certain chemical industries which were not dependent on particular species but could use wood of any kind. The aim was therefore modified to optimum use of the products of the tropical forest, and in some cases it became possible to set the number of economically usable species at a high figure. Silviculturists tried to devise methods permitting optimum use of the maximum number of species and economic conversion of the growing stock into less heterogeneous, and hence more fully utilizable, types.

The difficulties encountered in introducing the various silvicultural and utilization techniques required to this end have led many experts to advocate the eradication of virgin tropical forest and its replacement by pure stands. This attitude, which until recently had few proponents, seems today to be gaining ground, chiefly as a result of recent surveys made with a view to establishing new pulp mills in the tropics; a series of studies undertaken by FAO and UNESCO suggest greatly increased demand for paper in future and a trend to decentralize the pulp and paper industry.[2] Because of the rapidity of growth of certain species under tropical conditions and the technical advantages of working pure stands, many people recommend the creation of pure softwood or hardwood stands as the only solution to the problem of continuous supply to proposed new pulp mills.

Broadly speaking, then, three schools of thought have emerged in tropical forestry:

1. improvement of existing stands:
2. gradual conversion of mixed forest into less heterogeneous types;
3. transformation of mixed growing stock into pure stands.

This is no place to make any pronouncement on the relative merits of these processes but perhaps some general principles can be drawn. It seems reasonable to infer that:

1. it is essential to alter the composition of heterogeneous virgin forest;
2. conversion should render easier the economic extraction and utilization of forest products;
3. some methods of conversion may be dangerous both to the forest and the soil.

Therefore we may say that *tropical forestry must, wherever possible, seek to convert a heterogeneous growing stock into more readily and economically usable types, but conversion techniques must have due regard to climatic, soil, and vegetation conditions so that the new stands to be formed shall be stable and without hazard.*

In many cases, this principle will most properly lead to gradual conversion of stands through improvement by normal silvicultural methods. However, it does not preclude making radical changes under proper safeguards, such as artificially introducing native or exotic species, even in the case of protective forests, though here the concept of stability is of cardinal importance and must be the prime concern of the forester.

This principle also holds good for reforestation in arid regions, where the forests are ordinarily of no great economic value and serve principally a protective role. It is common experience that cash yields are the best argument for the protection of a forest. Even here, then, a cautious enhancement of the commercial value of the forest is advisable.

In considering our second principle economic considerations are always to the fore. A third which we will try to formulate rests purely on economic factors. We have said that in converting tropical forests, their stability must be maintained. This raises a series of technical problems to which foresters have devoted much study.

All experience shows that large-scale forestry operations cannot be undertaken purely on technical grounds. To be practicable they must eventually be able to pay their way, preferably tangibly in hard cash.

It is always technically possible to reforest an arid area or convert a mixed tropical forest into a stand of more desirable composition. The crux of the matter is whether such an undertaking is financially sound. Tropical forestry needs in most cases to get beyond the purely silvicultural research stage, however desirable

[2] The prospects are summed up in the FAO report *World Pulp and Paper Resources and Prospects* to be published shortly.

this may be in itself, and to have regard more to economic considerations. We would, in fact, suggest a third principle of tropical forestry to the effect that *forestry must especially be orientated toward perfecting techniques and practices that are sound financial propositions, given the difficult local conditions, the forest types, the social structure of the country, and, above all, the uncertainty of future requirement trends, so much less easy to predict than in the temperate zones.* Techniques and practices must be appraised not only on the basis of the cost of initial work required but also on the probable cost of subsequent operations that will become necessary in the light of the long-term purpose of each operation, whether it be for protection or straight profit.

This principle seems particularly important because it lays stress on local circumstances, economic and social. For instance, desirable silvicultural practices such as improvement thinnings in heterogeneous forests may be practicable in densely populated countries like Puerto Rico or Java where the products have an appreciable market value and the proceeds can help defray the costs of the operations. In the Amazon or parts of Africa, on the contrary, the products are just so much waste. So are the intermediate yields from artificial plantations established either for protection or timber production when there are as yet no local markets. Such forestry undertakings are, therefore, risky and of value only over the long-term.

Foresters must be sure what finally they want to achieve before choosing their silvicultural methods and assessing the probable results. This is perhaps their most delicate problem because it needs a brave man indeed to predict the course that industrial technology will take or the future requirements of local or foreign markets. It is axiomatic to say that the forester works for future generations, but he must not jealously guard to himself the right to look into the future. We go back to our first principle and the need for long-term integration of forestry into a wider planning.

Industrial aspects of tropical forestry

At this stage we may attempt to clarify established principles underlying industrial developments in tropical areas, planned or already under way, though this lies somewhat apart from forestry proper. There are two principles which should govern how the forest shall be managed, the one a corollary of the other. First, total utilization of the tropical forest, and second, integration of forest industries. Recent experience in underdeveloped countries has shown how difficult it is to put either fully into practice, however the ideas may be subscribed to in theory. Total utilization and integration remain the best means of attaining the desired objectives; but they are not, in themselves, objectives to be achieved at any price in the first stages of industrialization.

During the early development of a country, it is not financially practicable to establish a series of properly integrated forest industries or special industries that can utilize all available products of a forest. Planning must be on a practical business basis and the initial start must be made with industries that are both technically easy to establish and sufficiently profitable to amortize the capital investment. It is a question, above all, of markets, although even the initial industries should be designed with a view to their ultimately fitting into a pattern of fully integrated use of the forest as markets and finance permit. The principles remain valid, but they must be realized slowly.

This digression into the field of industrial development is important so far as forestry as a science and art is concerned because a more gradual evolution of forest industries than was advocated a few years ago will make it the more practicable to adapt forestry techniques to commercial needs, which is inherently one of the most difficult problems of tropical forestry.

Special protection problems in arid zones

So far our discussion on tropical forests has related primarily to the humid tropics. But the forester in the inter-tropical zone may also be confronted with dry, semi-arid and arid, and even desert, areas.

Without wishing to raise arguments as to the origin and evolution of the special climatic conditions in such regions, we are on safe ground in saying that many parts of the globe, now barren, were still comparatively densely forested within historical times. While climatic changes may have initiated the disappearance of the forest, man by persistent deforestation has certainly aggravated matters.

Foresters and conservationists are well aware of this fact, but it still needs to be repeated to prevent mistakes by those laymen in such matters who, however, as officials, must yet judge and decide on high-level forest policy.

Perhaps we may put it as follows: although certain extreme climatic conditions leading, in some regions, to the formation of actual deserts, cannot be considered as being initially caused by man, the aggravation and advance of these conditions is certainly to be attributed to him. *While it may not be prudent to envisage radically changing such conditions through forestry measures alone, it is essential for the forester to counteract directly the actions by man that have conduced and still are conducing to the encroachment of the desert*

In this way we limit the scope of the forester's responsibility; to define it more accurately we may run over the many services rendered by the forest, or rather that can be rendered by new forests, in arid zones.

Their value from the protection standpoint is discussed in another paper in this issue of *Unasylva*. The main interest lies in the part they play in protecting the soil, particularly against dessication and intensive wind erosion. The effect on moisture exchange between air and soil is also far from negligible, particularly when the plantations form a compact extensive block rather than scattered units, although admittedly such influence is local.

The interplay between the forest and the rural communities is just as great as in the humid tropical regions. Forest clearance is, as we have seen, one of the chief ways in which man aggravates the extreme climatic conditions to make agriculture difficult and to favor the spread of desert conditions. The forests in the parts of the dry zone with relatively good rainfall, which are the areas best for agriculture, are those most gravely threatened: the pace of shifting cultivation tends to quicken and very soon natural regeneration

of the existing forest becomes impossible. It is here that thorough investigations of remedial action suitable locally must be made and protective measures taken to halt or limit malpractices in the very interests of the local inhabitants. It may in many cases be necessary to change entirely the local economy if total ruin of the still existing forest areas is to be averted.

The wetter regions merge into the dry, arid and pre-desert zones with their special steppe type vegetation and these are the domain especially of graziers and nomadic herds of livestock. The use of these typical forest range areas confronts the forester with technical, social and often even political problems.

Finally, the open woodlands or savanna forest in arid areas have always some kind of economic value which in itself is an incentive to their thoughtless destruction. The forester must arrange to meet local needs for timber and fuelwood without risking the disappearance of the trees.

Perhaps we may sum up as follows. Forest and woodlands in dry, arid and sub-desert regions must be resistant to extreme climate and to the action of man. It is precisely this which is technically very difficult and in terms of money very expensive. *Remedial measures should always be on a large scale and in accord with long-term policy framed with due regard to the many potential services of the forest.* The effect of forest on local climate is limited; *therefore, in improvement works one must, near areas of permanent cultivation, deal in very extensive areas according to preconceived plans for sound land and natural resource use*; and the agricultural economy must, if necessary, be reshaped to permit proper protection of forest and range.

In view of the technical difficulties and the costs involved, *the various operations required must be performed as economically as possible — they should take the form of broad protection measures or very elementary silviculture.* In afforestation, inexpensive methods adapted to extremely dry regions must be employed; methods commonly used in temperate climates, with or without irrigation, can only be practiced in special circumstances, chiefly to meet particular industrial needs.

Forest research in the tropics

Whether in the wet or dry tropics there are two types of problem with which forestry is confronted, technical and economic.

The object of forest research is to solve the technical problems and this is comparatively easy to do with good organization, well-planned programs, and able technicians and research workers, although there is a difficulty in seeing that research relates directly to practical problems and specific local conditions and does not wander off into the abstract. As already shown, the goal of forest policy and management is still in many cases not yet defined so that it is not always easy to set the tasks for research. Some research must of course precede and help in [illegible] but most research is needed to gauge future possibilities. It must relate, therefore, to properly formulated programs. Here we see the need for a definite tie between planning and research.

Tropical forestry raises new, vast and complex aspects of science. The diversity of the problems to be solved by research has led to advocation of world co-ordination and centralization of research in order to eliminate duplication of effort, and expedite and improve the quality of the work. This idea, which is an application on a world scale of the now accepted principle of the utility of regional research, is certainly attractive and should not be rejected outright, but there are serious drawbacks to directed research.

The value of regional research lies in the fact that some courses of investigation relating to a specific "subject" or "site" can readily be centered for any given region; for instance, a central poplar experimental station for the Near East would not be difficult to envisage nor a forest experiment station for the Tropical Andes in South America. For the tropics as a whole, however, even where conditions of soil, climate and altitude are comparable, different economic, social and political backgrounds completely distort the picture. Forest research can hardly be conducted in Puerto Rico for application in parts of New Guinea because the whole concept of forestry is different in the two environments. Such difficulties are not insuperable, but they do lessen the degree of world centralization possible, bringing us back to the regional approach, although not altering the need for world-wide and co-ordinated exchange of information which remains an indisputable necessity from a purely technical point of view.

Highlights of tropical forestry

This paper in no way attempted to be a scientific analysis of the difficult problems facing tropical foresters. Its purpose is to "think out loud," and give some order to certain facts and principles. If these principles are deemed acceptable by the Fourth World Forestry Congress, discussion on the urgent features of the technical problems underlying the principles may profitably be resumed.

A forester not conversant with tropical conditions may regard what we have said as neither particularly original nor apt only to the tropics. This is, indeed, correct and goes some way towards answering the question raised right at the beginning as to whether tropical forestry should be regarded as a separate discipline. But the points and principles we have raised bear reiteration because they stand out as highlights in the experience of all whom FAO has consulted on the subject of tropical forestry. Tropical forestry should be seen not as some strange and awesome subject but as a matter to which all foresters can make commonsense contributions.

Protective Functions of the Forest

Relationship to Soil and Water Conservation

It is an accepted principle that, apart from any considerations of timber needs, some areas in any country must be maintained permanently under good ground cover which fulfills certain protective functions.

Generally speaking, reasonable utilization of such vegetal cover is in no wise inconsistent with its protective function provided it be maintained at its optimum density. But if natural growth is replaced by cultivated crops which leave the ground exposed or ill-protected for part of the year and every year remove a certain portion of the soil's organic matter and minerals, the land may become too impoverished or too deteriorated for native vegetation to re-establish itself, and hence a protective factor is temporarily or permanently lost.

In many cases, however, the need to give more land over to cultivation may prove imperative. Techniques of soil conservation, old in principle but now possible to apply on a vastly wider scale owing to the development of mechanized equipment and availability of effective fertilizers, permit intensive cultivation on areas once reserved to extensive agriculture and also, in theory at least, on sites which would a century ago have been unhesitatingly assigned to forestry. Consequently, there is less force behind certain tenets which have hitherto determined the categories of land to be retained under permanent natural cover, for example, angles of slope beyond which the soil should not be cultivated.

Because they are becoming less costly, old techniques such as terracing and contour farming can now often be used on very steep slopes, and help to provide not only for soil conservation but also for water absorption and storage, once thought to be the peculiar functions of natural cover. Similarly, it may be that under systems of shifting cultivation, the role of the forest fallow in restoring soil fertility may be supplanted by the correct application of fertilizers, even in tropical regions.

For both reasons of cost and social custom, such farming methods cannot everywhere be introduced. It is, however, certain that they will come to be used more extensively as each country is developed and as an increasing population demands more food production. In matters of land use, therefore, the choice between agriculture or natural renewable resources will tend to be decided on economic or social considerations rather than by any comparison of their relative efficacy in protecting the soil and its fertility.

In these circumstances, foresters must try to clarify their thinking as to what exactly is the protective role of permanent ground cover, conduct research to test its actual importance and the influences of various types of permanent vegetation on the same site. Lastly, they must define the factors involved in any determination of what can be described as the "absolute minimum protective area," that is, the minimum area that should be maintained under natural plant cover for purely protection purposes.

In practice, no doubt, this absolute minimum must be considerably exceeded. A reasonable minimum for each country will have to be assessed in the light of the whole economic and social situation. Where modern methods of farm management cannot be satisfactorily introduced, more permanent ground cover must be kept intact, although it is not yet established that such management methods can in fact wholly substitute for permanent ground cover, or at least for certain types such as dense forest cover: this is another question worth investigating and which cannot be lightly decided. However that may be, the fixing of the "absolute minimum protective area" is obviously very important, and it is for this reason that the Fourth World Forestry Congress has been asked to re-examine the value of the traditional conception of the protective forest, and to find out how far the criterion of protection can guide countries in deciding upon the areas that must, at all costs, be maintained under or restored to a permanent vegetal cover.

Role of Vegetal Cover

Protecting the soil itself

The protective function of permanent vegetation may be considered as having two facets that are, in fact, closely interrelated. First of all, the vegetation affords protection to the soil itself; it stabilizes, or at least ought to stabilize, the soil. Secondly, at the same time it conserves its properties.

Soil stability is of cardinal importance. Now ground cover may consist of trees, shrubs, bush or perennial grass species, or else a mixture of these various types. From the economic standpoint and even for other reasons, the type of cover is obviously of some concern, but does it matter purely from the standpoint of soil stability? This is still a point of some debate which probably can only be answered for any given locality by research. But it seems that any type of vegetation which is sufficiently dense to protect the soil from direct impact by rain, allows water to infiltrate into the soil and stops surface runoff, satisfactorily ensures soil stability.

On the other hand, as regards retention of soil properties, whether it be texture, chemical composition or biotic content, then the type of cover is obviously a prime factor. Unfortunate experiences with monocultures of exotic tree species have clearly shown the danger of planting programs which, originally, seemed admirable in concept. It is still not proven whether it

is silviculturally sound to induce in some second-growth stands, a growing stock short of the climax type, where the species may commercially be more valuable but certainly do not provide the ground with as good quality cover. In the tropics, the substitution of grass cover for forest cover appears to lead rapidly to irreversible changes in soil structure; relatively fertile soil will often be changed so that forest can never re-establish itself and the potential economic value is gone or made negligible. In some instances, soil fertility may be impaired to such an extent that no kind of soil cover can anchor the soil, and accelerated erosion results.

Maintenance of soil equilibrium

The aspects considered above would be of relatively minor importance if the disappearance for any cause of natural plant cover affected only the immediate area where that cover originally occurred; the damage would then be within calculable limits. What we generally mean when referring to the protective functions of vegetation is something more — the indirect influences on adjacent and other lands and soils, and it is this which must be taken into account when it comes to determining any "absolute minimum protective area."

Much research on such influences has been and is still being carried out. It would be valuable if experts at the Fourth World Forestry Congress could appraise the findings to-date, since the truth in this matter must be one of the foundations on which forest policy must be built. Each of the many aspects of forest influences could usefully be reviewed, even if the conclusion is likely to be that experience is still too brief and especially too localized for any general conclusions to be drawn.

Mechanical protection

The protection afforded may, in the first instance, be purely mechanical. As far as the forest is concerned, this is an elementary role long recognized. For instance, communities living on exposed slopes in mountain areas maintain patches of forest above their houses as protection against landslides and rockfalls; the fact that the trees are grouped in isolation in the middle of land cleared elsewhere for grazing or cultivation is evidence that they have been retained there intentionally. Moreover, the character of the woods shows that cutting has been kept to a minimum or even strictly prohibited, despite proximity to the village.

Protection against avalanches is also a purely mechanical service of the forest. Even relatively dense forest cannot, of course, withstand the full force of an avalanche or the shock of the ensuing air blast, but it helps to anchor the snow and prevent slides gathering momentum. Since dangerous avalanches usually start above the natural tree line, much research has been devoted to finding hardy tree species and races that can be introduced artificially at high altitudes to aid in controlling critical zones. It is to be noted, however, that not all types of woody growth have protective value; low brush, for instance, buried to the top or nearly so, can facilitate the start of avalanches by causing uneven packing of the snow or the formation of inner cavities.

Fixing shifting sand

The effect of plant growth in anchoring shifting sand can also be classified, at least in part, as mechanical action, although it is more complex than in the preceding examples and the results more problematical.

However, a useful function can be served by indigenous or exotic plants and trees in fixing windborne sands; the fixation of the fine particles of sand, of course, is not due solely to the binding action of the compact and complex root systems of the herbaceous or woody vegetation able to grow under such conditions. As a humus layer forms, this also tends to anchor the sand, as does the higher moisture content below the plant cover; the above-ground vegetation helps to break the force of the winds that cause shifting sand dunes.

Unfortunately, shifting sands are generally a phenomenon associated with regions where forest or any other type of vegetation is inevitably difficult to establish or maintain. In some coastal areas, the salinity of the soil or of the wind driving off the sea prevents the use of all but a very few plant species; in arid zones elsewhere long periods of drought and sharp fluctuations in temperature are distinctly unfavorable to plant growth. The choice in species to be introduced or maintained is, therefore, very limited.

Still, in the last fifty years on every continent much research has been carried out on the important problems of arresting driven sand. The Fourth World Forestry Congress should express an opinion as to the extent to which the results of such research enable any of the countries directly concerned to check the advance of the desert and to restore in arid areas conditions favorable to human life, farming, grazing and forest.

Climatic influences

The part played by extensive forested areas or natural grasslands in forming the pattern of world climates is still a matter of considerable debate. But it represents a type of protection of a distinctly physical or physiological nature which, though little studied, may be of major significance from a regional, and even a world, standpoint. The type of research involved comes up against the fact that knowledge of climatic changes and their causes throughout the world, even within historic times, is inadequate. Has man, by the modifications he has wrought in the vegetation in some parts of the globe, significantly contributed to any of these changes? It is certainly not easy to decide the impact or scope of man's action and there are no historical data to go on; so what methods and techniques of investigation should be used? This is a question which badly needs an answer.

Many observers have reported that there has been a definite recession of the forest in some parts of the world, especially in Africa. Increased population, the introduction of crops demanding forest clearance, and the persistance of certain destructive practices such as uncontrolled use of fire, all indicate that the recession is likely to continue, perhaps more rapidly. What is to happen, for instance, when the vast forests of central Africa are destroyed or reduced to a mere fraction of their present area is obviously a sociological and economic problem affecting not only the peoples of Africa but perhaps also of the whole world.

The results in some countries of some truly large-scale projects to create forest belts as a protection against searing wind and dessication tend to show that a real modification in climate can be brought about. The effect of extensive forests on moisture-laden winds may be quite different to those on dry winds, but we ought to know for certain. Certainly an investigation of the protective role of natural vegetation in relation to world climates is of cardinal importance and is the type of study that might suitably be undertaken jointly by several United Nations agencies.

Water supplies

Much research has been devoted to the influence of natural vegetation on water supplies, and several countries have spent substantial funds and set aside considerable watershed areas for experiments on run-off conditions under various patterns of vegetative cover. Experiments of this nature are important in that they make it possible to appraise the relative effects of various types of cover on the quantity and quality of water supplies. Results in one locality, however, often do not hold true elsewhere and much more scientific research is needed to evaluate "forest influences" in this respect and provide a reliable basis for decisions on what areas should be reserved to forest or other types of natural cover, and whether cutting and other forms of utilization should be altogether excluded or strictly controlled.

Even without research, common experience seems amply to substantiate the Russian saying that "the forest is the mother of water," and has clearly revealed that only sound management of watersheds, with thriving natural vegetation covering a minimum area, is likely to guarantee a regular streamflow, limit flood damage, check accelerated erosion, reduce the silting of reservoirs, prolong the life of dams vital to hydro-electric industries and irrigation, prevent the gradual choking of estuaries, and provide large urban centers with constant supplies of good water.

But experience gained the bitter way is no substitute, insofar as framing forest policies is concerned, for research and the systematic collection of information. This costs money and it is a sad reflection how few countries are prepared to understand this. In 1951 the well-known authority E. P. Stebbing undertook a world enquiry into what may be considered the essential foundation of a general understanding of the relations between water and forest, or the study of "the sources of rivers and tributaries to find out definitely what proportion of forest clothes their catchment areas, its type and how managed." Despite the quantity of data collected, Stebbing had to conclude his work with these words: "It has proved an interesting study, if only from the point of view of the extraordinary meagerness of available information." The widespread lack of understanding of any need for deliberate watershed management is a topic that ought to engage the attention of the Fourth World Forestry Congress.

Though research experiments that can yield useful and reliable data for analysis are difficult to devise, there is already quite a body of knowledge available today from which general inferences can be drawn. Two points, however, should be borne in mind.

First, analytical studies should also lead to a "synthesis," in other words to constructive conclusions. The fact that a forest massif causes more abundant precipitation or greater condensation of atmospheric moisture is undoubtedly of certain significance. But what we really want to know is the balance, season by season, between the precipitation and the water available for consumption or use by man. We must be enabled to draw general inferences from analysis of the particular influence of natural cover on rainfall, evaporation, transpiration and infiltration.

Second, the objectives, and consequently the orientation to be given to research, are not the same for all catchment areas, as may be seen by taking two extreme examples. In the case of a watershed in a mountainous region where slopes are steep and the rainfall abundant and well distributed, the object will be to obtain a regular streamflow and an effective protection against erosion. In the case of a hilly watershed with scanty rainfall and long periods of drought, the principle object will be to secure the maximum infiltration of water and its subterranean storage until it is required, say for the irrigation of areas located below the watershed.

The implications of the second case just cited above deserve consideration because foresters have sometimes been reproached for not being sufficiently circumspect when making plantations, in that the species planted, using a great deal of water, have apparently affected the flow of streams and even rivers. Sometimes criticism seems justified. Foresters must, therefore, be objective in seeking the best solution for each particular case. Plantations of merchantable timber may not be the answer to watershed management in certain climates; the effect of such plantations should be compared with that of other types of permanent vegetation, such as low brush or grass. There have been long arguments on the relative merits of high forest and grass (assuming that both are kept in proper condition) in erosion control and preserving soil structure in connection with water infiltration; in Australia, to take one example, the protective effects of eucalyptus stands have been attributed to the herbaceous ground cover, not to the trees, so in no case should *a priori* conclusions be drawn. It is obviously desirable that the protective cover on watersheds be at the same time of high financial value, but grass cover, if suitably utilized, can also give high financial returns. Moreover, if the principal object is to obtain water yields, it must not be forgotten that in broad economic terms the water may be worth very much more than either the possible timber or fodder yields.

Plantations "outside the forest"

In the last 20 years much research has been devoted to finding out the actual protective effects of tree plantings as windbreaks, shelterbelts, and hedgerows around cultivated fields.

The establishing and upkeep of such borders are nothing new for most countries. Judicious planting can be a great asset to farmers especially in relatively poorly forested areas: the main purpose may be economic, to supply timber and fuel and also in some cases to yield a fodder supplement, but these uses, although important, are not what concern us here.

The effects of windbreaks and shelter belts are now fairly well understood. The desirable sizes, shapes and spacing of trees to obtain certain effects are in general also known, although some points of local concern still need to be clarified by further research. The remaining issue to be decided for each particular case is the species that are adapted to the local climatic and edaphic conditions, and which will grow vigorously enough to produce the desired result in a short time.

The indirect effect of windbreaks on evaporation due to reduction in wind force has also been thoroughly studied, and here it is well to remember that the trees themselves will use or cause to evaporate a certain amount of water. Also they take up room and may be demanding in organic and mineral requirements, so that they may lower fruit and crop yields. In some instances, they may shelter animal and insect pests. But on the credit side their action is not restricted to protection against wind and evaporation; where much of the precipitation takes the form of snow, windbreaks help spread the snowfall evenly, usually retard the melting of the snow accumulated on their edges, facilitate infiltration after thaw, and reduce runoff.

Wherever the establishment of shelter belts and windbreaks appears advisable either for economic reasons or as a means of wind erosion control, further research and analysis should be made, especially as regards effect on average crop yield. As valid findings can only be drawn from averages, research will be a lengthy business. In fact, not only do climatic conditions vary from one year to another, but soil losses through wind erosion become measurable only after many years. Further, protective belts are only fully effective when the trees have reached full size. Figures revealed so far on higher crop production on land protected by windbreaks are certainly very encouraging but before they can be accepted as conclusive much more research needs to be carried out.

The same may be said in regard to the common practice of border planting along irrigation canals, around reservoirs, or alongside roads. The advantages and disadvantages of such plantings, either including or excluding their economic value, need to be realistically assessed. The answer will probably be favorable but at least a proper understanding of their true value is essential to forest policy decisions and to foresters who have to give effect to policy.

Deviating still further from the forest proper, the actual influence of *taungya* methods of cultivation, a common practice in many countries, on soil conservation and the water cycle, as well as the effect on crop yields and on grass production, could profitably be established. The idea that multiple use, combining forestry, agriculture and grazing, is the best way of using some types of land, originated in the Mediterranean countries but has already been widely adopted in other regions and is increasingly gaining ground.

Forests and health

Studies are also needed to determine the influence of forests on air purification and on human health in general, an attribute which appears to be firmly recognized at least in the temperate zone. An example often cited is the establishment of the Landes forests in France at the beginning of the last century; this is credited with a striking expansion in the local population, a drop in the mortality rate and a general improvement in health. Town planning authorities rightly try to set aside greenbelt areas around and even within urban areas for "fresh air" and recreation.

On the other hand, in the tropics forests are often regarded as unhealthy and enervating areas, mainly because they shut off the breeze which is such a feature of relief in tropical climates. Also, of course, they frequently shelter harmful insects and pests of man and his livestock. The need to eradicate tsetse fly and other livestock pests in some parts of Africa is used as an argument by those who are radically in favor of forest clearance, although there are methods of destroying these insects or rendering them innocuous other than by razing the forests.

Biological balance

Lastly, the question of the general optimum biological balance and of the part that has to be played by various categories of natural cover is a matter that can only be elucidated by broad regional or world-wide investigations for which at present only the most fragmentary data are available. Indeed many basic factors involved must remain unknown for a very long time to come.

The clearing of a small forest area or the burning over of a limited area of natural grassland apparently carries little permanent effect. When the land is left to itself, usually the original type of vegetation gradually returns and so the primitive balance is restored by nature. But if such operations are repeated at short intervals, if they cover extensive areas and if, by design or accident, the natural climax vegetation is prevented from re-establishing itself — as has been happening ever since man tamed his environment — then the disruption of the natural biological equilibrium may be much more serious.

The near-sightedness of man means that he is only aware of immediate consequences of this disequilibrium, such as a deterioration in the soil he cultivates, which may indeed often be serious enough to induce him to take some counter-action. Generally he has no conception of the remote effects in time and space of the unbalance he brings about.

What effect has the wholesale clearing of wide areas had on the climates of the world? What effect does the deterioration of upland range and forest in the watershed area really have on the meandering of a large river and on the silting of its estuary, perhaps thousands of kilometers away? What is the effect on animal populations of changed environments and on the insect pests and parasites of these animals? Lastly, what is the effect on man himself who, after all, is only one of the living creatures of this planet?

Without doubt there is no question of conserving or restoring an original balance for the mere satisfaction of so doing: man's whole progress is bound up with changes in nature which in fact are both cause and effect. But one has only to look around the world and note the regions that have become barren, to be convinced that caution is necessary. Modern man's outlook has broadened, and he is beginning to be aware of the interdependence of people everywhere. Now it is essential for him to weigh the far-reaching conse-

quences of each new change in his environment which he wants to bring about.

Understanding of the biological balance becomes the more urgent as man attains more powerful means of altering it. We are convinced that knowledge of this sort would provide the scientific basis on which it would be possible actually to define those parts of the globe that must remain under the protection of natural cover to forestall progressive impoverishment of the peoples for whom the soil represents the sole permanent wealth.

Teaching Conservation to the General Public

It is still of little use to build up a science, however valuable, so long as its lessons are not applied in practice. Fortunately, in this case instruction in conservation can precede the full elaboration of the science.

Conservation in the now commonly accepted sense means the wise management and use of renewable natural resources, and its primary object is to preserve the productive capacity of these resources. We are not concerned here with teaching conservation to the experts actually dealing with these natural resources, although we would mention that in some cases it would be an advantage if their training gave them a broader perspective of the interdependence of all forms of land use. What we are especially concerned with is the education of the population as a whole, and in particular of those laymen who can greatly influence public opinion.

Undeniably considerable progress in this respect has been made in many countries. Many praiseworthy efforts on the part of governments have been reported to FAO in regard to publicity campaigns, adult education, teaching of children, organizing of "tree festivals," and so on. Other means used that come to mind are allotting tree nurseries or woodlands to schools; talks, films and television programs for students or courses for their teachers; publicity through posters, the press, radio and television; the organizing of "Friends of the Tree" societies and of child, youth or adult nature study groups; and extension work among private owners or users of forest and range.

Is this enough? We do not think so. Usually these various means have only a passing attraction. The idea that conservation is a vital and personal matter is still not successfully conveyed to individuals — whereas we should be seeking to make conservation of natural resources as much a natural instinct as self-preservation. There is in fact a similarity between the two ideas: for the present generation has only temporary use of the world's soils and should hand that trust on to future generations with the soils' productive capacity unimpaired if not improved.

A few countries have already come close to this ideal, which proves that it is in no way impossible of accomplishment. Even in countries where bread is plentiful, children are taught not to waste bread: why should it be more difficult to teach them respect for an infinitely more valuable asset — the soil that produces the bread, together with all the other good things indispensable to human life? In fact, the education of children and young people should be imbued through and through with the theme of conservation. Constant reference to it should be made in teaching the elements of all the sciences that directly concern man — history, geography and the natural sciences. Elementary geography books explain the water cycle to children: is it more difficult to explain that this cycle is not unchanging and that man-made erosion is a threatening phenomenon?

An international campaign

Creating an enlightened public opinion is essential — and a preliminary step in this direction is the education of the governmental and political circles in any country. This is the task of professional foresters and men in industry and trade.

Considerable time may indeed elapse before their arguments are heeded, especially if such counter measures as they propose clash with tradition, accepted rights, or deep-rooted custom. In one great country which is now applying strict measures for the protection of its soils, serious erosion damage was reported as early as 1900. Yet, despite the farmers' outcry, the alarming reports of special investigating commissions, and the clear evidence of damage in years of exceptional drought, it was not until 1933 that the first soil rehabilitation measures were taken by the government which, from then, had to expend yearly an amount equivalent to 25 million dollars. Misuse and consequent erosion, however, had already caused some injuries that were irreparable. Serious changes in streamflow, the drying up of many rivers, the deterioration of range and cultivated land stemmed from ill-regulated grazing by sheep whose number had quadrupled in 30 years and by cattle that had increased threefold, from bush fires, from thoughtless clearing and from bad farming practices. By 1933 four large artificial reservoirs built between 1920 and 1925 had been reduced to from 14 to 45 percent of their initial capacities.

It is important, therefore, to provide experts with force for their arguments and to give governments justifications so that they can introduce measures now rather than later — measures that, if too long deferred, may be wildly expensive and only a partial remedy for an already irreversible process.

This, it is suggested, could in part be done through the formal and solemn recognition, at high governmental level, of certain basic principles of soil conservation policy, to be followed by a vigorous campaign for their adoption in practice in all countries of the world.

Because the forest is the key to the conservation of all soils, it would in no way be out of place for foresters to take the initiative in launching such a campaign, and an occasion such as the Fourth World Forestry Congress would be an appropriate opportunity to do so.

It may in truth be objected that the formulation of valid general principles of soil conservation is most difficult because of the widely different soil and climatic conditions throughout the world, as well as the differences in social structure and technical and industrial progress. The difficulties are indeed great but not insuperable: we are not thinking in terms of static but of functional principles.

Correct land use and soil conservation go hand in hand: but some types of land use, and a specific blending of various uses, will be suitable for one type of national economy though not another. Not every country, then,

can subscribe to utilizing a given category of land in a specific manner, termed "correct," although all perhaps could agree on the uses to which that land should not be put. Limitation in use and balancing of uses — taking into account physical, economic and social conditions — must, it seems, underlie universal principles of soil conservation.

Supplementary to these general principles, specific principles for each kind of land use are necessary, and these, for forestry, have already been formulated and recommended by the Member Governments of FAO.

It is not known what view the Fourth World Forestry Congress may take of this whole line of reasoning. The Congress will, however, undoubtedly concede [illegible] emphasis to the forest's role in soil conservation [illegible] what the forest can and should do in the rehabilitati[illegible] of deteriorated lands, and this in itself is highly impor[illegible]tant. The economic value of the "forest" in the broadest sense is a concept for the most part easily understood; its protective value, often far superior to its productive value, still too often lacks appreciation.

In reality the protective and productive roles of the "forest" complement each other. But in a world where "progress" seems to carry serious dangers for the forest, we must again and again stress conservation and protective functions.

FAO — WHAT IT IS

FAO — The Food and Agriculture Organization of the United Nations — grew out of the United Nations Conference on Food and Agriculture held at Hot Springs, Virginia, U.S.A., in May 1943.

Toward Freedom from Want

At that Conference 44 nations agreed to work together to secure a lasting peace through freedom from want. In particular, they agreed that international co-operative effort was needed to raise the standards of living of the under-nourished two-thirds of the world's population.

FAO was formally founded at Quebec, Canada, in October 1945 — the first of the new specialized United Nations agencies to be created after the war.

Forty-two governments ratified the Constitution at Quebec; by the end of 1953, FAO's membership had risen to 71 countries. The chief aims of the young organization were defined as follows:

- to help nations raise the standard of living;
- to improve nutrition of the peoples of all countries;
- to increase the efficiency of farming, forestry and fisheries;
- to better the condition of rural people;
- and, through all these means, to widen the opportunity of all people for productive work.

How FAO is Organized

FAO is governed by a Conference, normally meeting once every two years, in which each Member Nation has one vote.

Between Conference Sessions, the Council of FAO acts as the Organization's governing body. It is composed at present of representatives of 24 Member Nations, elected by the Conference. It usually meets each spring and autumn, with brief meetings also immediately after each Conference Session.

The Director-General, appointed by the Conference, directs the work of the Organization's staff, appointed by him. The present Director-General, Dr. P. V. Cardon (U.S.A.), was chosen by the 1953 Conference. The Secretariat is organized into a central administrative group, five technical divisions — agriculture, economics, fisheries, forestry and nutrition — and an informational and educational division which includes the library and legislative services, publications and public information.

In addition to the Headquarters office, FAO has regional offices — in Washington for North America; in Cairo for the Near East; in Bangkok for Asia and the Far East; and in Rio de Janeiro, Mexico City and Santiago de Chile for Latin America.

FAO and the United Nations

Although FAO is an autonomous, independent organization, it is at the same time a member of the United Nations family of specialized agencies. With the United Nations itself, FAO works through the Economic and Social Council (ECOSOC). Collaboration is maintained with the respective United Nations Economic Commissions for Europe (ECE), for Asia and the Far East (ECAFE), and for Latin America (ECLA), all set up by ECOSOC.

How FAO Works

As an association of sovereign governments in what has been called an "international self-help co-operative," FAO's functions include:

Promoting and recommending national and international action with respect to research, improvement of education and administration, conservation, processing, marketing, distribution, credit, international commodity arrangements, and the furnishing of such technical assistance as governments may request in carrying out their activities along these lines in order to reach FAO'S objectives.

FAO is no super-government, has no executive powers, and is without authority or funds to buy and distribute materials or machinery, or to operate research laboratories. Through its functions it can help its Member States in two main ways:

1. by maintaining an intelligence service to gather, analyze and disseminate technical and economic information which the FAO staff and Member States may use as the bases of sound action, and;
2. by developing action programs to supplement those initiated by governments, which FAO, on the request of governments, can assist them to carry out.

Both activities are included in FAO's regular program. For 1954 and 1955 the budget was set at $6,000,000 annually. To be carried out on any wide scale, the second type of work — intensive direct technical assistance to Member States on the myriad problems of food and agriculture — requires more funds than such budgets provide.

Therefore work of this type was limited, until in 1950, governments, members of one or more of the United Nations family of agencies, created by their voluntary contributions the Special Fund for Economic Development of Underdeveloped Areas. About 28 percent of this fund has annually been available for work in FAO's fields, a larger share than is devoted to the work of any other single agency in the group. Thus FAO has had about $5,000,000 to $6,000,000 annually to finance the sending of technical advisory experts to help requesting Member States with their problems, including the training of their own people better to help themselves. This Expanded Technical Assistance Program (ETAP) is a logical extension of one aspect of FAO's work. It is directed by the regular staff. It rests upon the strong foundation given it by a continuing organization supplied with the necessary data, and experienced in the various fields of work.

Productive Functions of the Forest

Management for Wood Production and for Other Economic or Social Purposes

RECOGNITION of the protective functions of the forest and their importance to man is relatively recent. This awareness is long antedated by the use of forests in the production of other goods and services which must be as old, or very nearly as old, as the human race itself.

From time immemorial the forest has supplied man with useful goods: fuel for warmth and cooking, and materials for shelter, tools and transport. Though wood products have now changed in both degree and kind, and modern chemistry enables wood to be plasticized, moulded, laminated, impregnated and turned into a bewildering number of products, still roughly half our wood is used for fuel. And much of the remainder still goes, as in primitive times, into relatively crude materials for shelter and transport.

Indeed the qualities which made the forest of use to primitive man — its widespread occurrence; the variety, workability and adaptability of its produce; and its capacity for self-renewal after long use and even abuse — still operate as before to make it a basic source of raw materials. Conversely, the major disadvantages of wood from modern society's standpoint — its great diversity and often refractory and unpredictable qualities, but especially its weight and bulkiness, or more accurately its low value per unit of weight and bulk — are still a potent cause of local timber shortages, even in some countries with an abundance of forest wealth.

Taken as a whole, the forest resources of the world, especially if regarded in terms of available land, are still abundant enough to supply services and goods in ample quantity. The problem of forest productivity is how to make this great, versatile and renewable resource serve man to a fuller extent, to something at least approaching its real capacity. For economic expansion, increasing populations and rising living standards will make high demands on the forest for goods and services, demands that cannot be met with forests producing only a fraction of their potentialities.

This, then is the real challenge to world forestry, and conditions would now seem more favorable than heretofore to meet it. For, in spite of a world torn by dissension and hostility, the fact remains that for the first time in history nations have mutually bound themselves to strive in their own self-interests toward a more abundant production of goods from the soil as a basis for improved standards of living. A heartening program of mutual advice and assistance has been formulated and launched, and foresters are better organized internationally than ever before to co-operate and coordinate policies and action programs in the interest of the better use of the forest resource. It is in the light of these developments that we must survey the objectives and problems of improving forest productivity.

THE ROLE OF FORESTS IN THE NATIONAL ECONOMY

Before going on to examine what might be done to increase world forest productivity, it may be well to review the role of forests in national and regional economies and the policy problems involved in determining the forest areas needed in a sound pattern of land use. In brief, over and above its protective functions, the forest serves man by producing wood for fuel, housing, furniture, mining timber, sleepers, poles and other industrial uses; by yielding raw materials and chemicals for industry, chiefly cellulose for paper; by furnishing meat, hides, furs and wool from domestic and wild animals; and by affording areas for relaxation and recreation.

The magnitude of these services are perhaps best brought out by noting that forests proper occupy perhaps one-fourth of the world's land area, and produce in wood alone, the principal product, around 1,000 million tons annually, valued at 60 percent more than world production of coal and 100 percent more than crude steel or oil.

Forest and associated grasslands together occupy more than half of the world's land area, including grazing lands that are too dry, too rough, or too rocky for improved pasture; open forests and savannas where much grazing vegetation occurs under the scattered tree growth; desert shrub types, mountain meadows and alpine grasslands near or above the timber line; and the extensive tundras of the far north. Although the exact acreage of open grasslands may not be known, millions of people, nomadic herdsmen and others, gain their livelihood from these lands. And many more millions derive all or part of their living from processing, transporting or selling the meat, wool, hides, milk and other animal products from the wildland ranges. Just how much of the world's meat supply comes from natural range lands is not known, but it must be a high proportion. In the United States, about half the beef cattle and 70 percent of the sheep get a considerable part of their feed requirements from native ranges.

To the wealth in raw materials that the forest provides must be added the wealth created by manufacture. For much of this raw material is further altered by mechanical and chemical means into a great variety of useful and more valuable articles for human use. The value added by manufacture has been estimated at many times the value of the raw material for the more highly industrialized regions of Europe and North America. This is less important than the fact that the quantity of industrial wood consumed tends to reflect the industrial growth and development of a country and its economic strength. On a regional basis the stage of industrial development is crudely reflected in the figures shown in Table 1. Industrial use of wood varies from

about 10 to 12 percent of total cut in Africa and Latin America, to over 80 percent in the United States and Canada.

TABLE 1. – TOTAL AND INDUSTRIAL WOOD CUT

Region	1951		1952	
	Total	of which industrial wood	Total	of which industrial wood
	Million cubic meters – solid volume of roundwood			
Europe	266	161	261	160
U.S.S.R.	335	190	365	205
Canada and U.S.A.	381	310	375	309
Latin America	171	22	170	22
Asia	146	51	143	53
Africa	92	9	93	10
Pacific Area	22	11	22	12
WORLD TOTAL	1 413	754	1 429	771

Source: *FAO Yearbook of Forest Products Statistics 1953*

Only a few other salient facts need to be noted here. First, although the bulk of the roundwood harvested is still used in crude form, about half as fuel and much of the remainder as sawn material, the percentage used for more highly elaborated products such as plywood, laminates, and particularly paper and various paper derivatives, grows steadily. This results not only in the creation of new and useful products and the addition of considerable value in final products, with the concurrent values of useful employment of human labor, but from a forest production standpoint there is an important concomitant in the increasing percentage use of small diameter wood. The ability to dispose profitably of small wood of all species is still the key to good silviculture under most conditions. In addition, there is a slight but steady increase in the percentage of total roundwood used for industrial purposes and the rising value of wood thus indicated is an important lever, as can be readily appreciated, in opening up new areas and intensifying production from developed areas of marginal value.

The production of wood for fuel, housing, rural use, and transport; the production of meat, hides, fur and wool; and serving as areas for relaxation and recreation in a civilization of more exacting tempo — these will continue to be major uses for forests for any foreseeable future period. To such uses national policy should add, insofar as feasible, greater utilization and development of forests as a basis for trade and industry. Accordingly forest policy must, after due provision for the basic protective functions of the forests, consider forest productivity, and what this may mean in the national economy, in relation to a great complexity of local and regional factors.

DETERMINING THE AREA OF FOREST NEEDED FROM A NATIONAL STANDPOINT

What, then, are the criteria that must be used in determining national policies in relation to forest productivity? In general, policy must aim at "satisfying as far as possible the national wood requirements of the people of the country and its industries and [illegible] and foreign trade, after weighing the economic i[illegible] cations of imports and exports."[1] What does this me[illegible] when considered in more detail and as applied to n[illegible] situations?

Social factors

A basic principle long recognized by foresters is that the best land use and land management pattern is the one that will in the long run furnish the greatest good to the greatest number of people. From this standpoint, as already indicated, sound forest policy will recognize domestic requirements for food, fuel and primary shelter as of first importance. Among these, food requirements must take first place. Within limits, policy may reasonably foster colonization of forest lands and encourage forest clearing by land grants and subsidies, provided recognition is given to the need for a farsighted settlement of any real conflict in land use raised by the demand for food, and for a proper examination of the perplexing problems involving forested areas, especially in areas of already dense or rapidly rising population.

Although the needs for food are paramount, fuel and shelter are almost equally basic human requirements. This applies as much to the inhabitants of the Congo forests as to the Eskimos of the northern regions — neither could exist without fuel and shelter. And although this does not necessarily imply the they need wood, where wood is the most suitable material to serve these purposes, then experience indicates that there is a minimum in the amount of land used for forest production below which it is unwise to go, even under the greatest population pressures for land for other agricultural and industrial needs. This is true even for highly industrialized or agriculturally developed countries like Denmark, the Netherlands or the United Kingdom. It seems self-evident, therefore, that forest policy must give first consideration to real domestic requirements for fuel and shelter.

It is also evident, however, that these requirements will vary widely, not only with the abundance and availability of other fuels or materials but also with such social factors as the organization of society and particularly the stage of industrial development. For instance, the use of wood for fuel, usually most common in rural areas, ordinarily decreases rapidly with industrial development, and policy must take such factors and resultant trends in demand, into due consideration. The conversion of former coppice to high forest now under way in many parts of Europe, is directly the result of changes in domestic requirements for fuel wood which have affected management policies.

Social factors affecting policy include patterns of land ownership by the State, established "rights" or forest usages grounded in law or custom, and the need, particularly in well-wooded countries, for forested areas for recreation, national parks and for scientific investigations. It may be remarked that the spreading complexity and urbanization of modern life and industrialized societies increasingly brings into promi-

[1] *Forest Policy, Law and Administration*, FAO Forestry and Forest Products Studies No. 2, Washington-Rome, December 1950.

nence the need for forest and other "wilderness" areas just for recreation; this need may range from city parks or woodland areas in the country developed for the use of large numbers of daily or week-end visitors, to roadless areas presenting as far as possible primeval conditions in which all normal productivity use such as grazing or timber cutting is barred. Policy must take into consideration national and local needs which will vary with public requirements and desires.

Economic criteria

Closely related and integrated with the social factors just discussed are a number of important economic considerations basic to the development of sound policy. Indeed just as policy on protective forests deals primarily with forests in their "physical" aspects, forest productivity and related policy deals largely with forests in their economic aspects, as direct or indirect producers of tangible wealth. Foremost among such matters comes the problem of determining the quantity and character of the goods necessary to satisfy the domestic and industrial needs previously discussed; the determination of such requirements and related consumption trends are essentially economic matters. Coupled with a suitably detailed appraisal of present and potential forest productivity, such estimates form the essential base for determining forest policy aimed at meeting primary needs. Due consideration must also be given to the physical accessibility of forest areas and the relative value of the products, both of which aspects will determine economic accessibility. Sound forest policy will take into due account the building of an adequate transport and communications system; and also the promoting of research and inventions to create new commodities derived from forest products or to increase the worth of known products so as to raise the value of the growing stock in the forest and make its extraction an economic proposition. The development of more efficient sawing and machining techniques is an example of possible aid in this direction.

Similarly, sound economic policy will advance the development of a properly trained, and well-housed and fed, and therefore contented force of forest and industrial workers. Attention must also be given to the development both of internal markets and foreign trade, with proper weighing of export-import balances and due value, given to desirable degrees of national self-sufficiency. Also under this head will come measures to foster forest co-operatives where these are justified by circumstances; to develop reasonable schedules of forest taxation; provide forest insurance and, if in the public interest, to develop a system of subsidies or grants-in-aid to forest owners insofar as these are necessary to adequate forest production. In this respect, forest policies may often have to make public provision for forest roads, forest credits, and favorable marketing and taxation procedures.

Technical factors

Once the domestic needs and exigences of other factors have been reasonably well established, policy must, of course, give consideration to the character and size of both the existing and potential resource as affected by soil capabilities, the physical factors of climate and topography, and social-economic criteria. In this connection, particularly where land is a scarce commodity, national policy should not overlook the possibility of encouraging production, under suitable precautions, from protection forests, from hedgerows and roadside trees, and from shelterbelts and other "plantations outside the forest," which in fact already furnish a substantial part of essential needs in a number of countries.

From the standpoint of technical factors, sound forest policy must make provision for adequate forest protection against fire, disease, and insects, usually a public (State) function. It should help to develop intelligent and sympathetic public attitudes towards the forest by education. It should sponsor or even finance the research needed to develop proper silvicultural and management techniques for the nation's forest and range lands. Here also full production may require advice and guidance from the State, especially to private owners of smaller woodlands, in applying techniques to forest and range lands proved suitable by research or experience. An extension or educational program frequently requires public assistance or administration. In addition, national policy may in the public interest require the regulation of timber cutting on private lands or technical control of such cutting by competent professional foresters. Sound forest policy often includes public provision for forest protection, for free or low cost forest planting, for technical advice and guidance and other public grants-in-aid including the forest credits, favorable trade and taxation policies and a forest road system previously mentioned as compensating factors for restrictions placed, in the public interest, on private cutting or other private use.

Managing the Area Needed

In the foregoing synopsis much has been said of factors that must affect policy decisions on increasing the productivity of forests. From the practical point of view forest production can be influenced most materially by:

1. extending the area of productive forest and forest range:
   - (*a*) by seeding and planting;
   - (*b*) by making access to undeveloped forests economic through enhanced values for their products or by reducing harvesting, transport, processing and marketing costs:
2. improving management;
3. reducing waste.

The possibilities under each of these broad heads are many and varied and the following sections merely offer illustrations and suggestions from among the means available.

Extending the area of forest and forest range

Seeding and planting: One of the obvious ways in which to extend the forest area of a country is through large-scale planting. A considerable number of governments are known to have definite plans to stock areas not now forested, most of which were formerly covered with forests. In western Europe, for example, there are

plans to establish 10 million hectares of forest plantations over the next 25 years, although much more than this amount is really needed. A number of countries in Asia, anxious especially to increase fuelwood supplies, are committed to establishing plantations principally for the production of wood for fuel and charcoal. Some of these plantations are to be irrigated; in most cases the land to be used is not now producing useful crops of any kind.

In some parts of the world considerable success has attended efforts to establish plantations of fast-growing species for special purposes. Outstanding have been the plantations of newly-developed hybrids of poplar in some European countries, in Argentina and Uruguay in Latin America, and in the United States. The effort is now being extended to the Near East. Through the International Poplar Commission, a body sponsored by FAO, experts drawn from many countries have been exchanging information on research and experience and the practical results of their activities are seen in the increasing areas and yield of poplar plantations. Similarly the introduction of many species of eucalypts [2] has been successful in countries along the North African seaboard and in South America. The famous *Pinus radiata* has been grown successfully in New Zealand, Australia, Africa, and South America, notably Chile, to create new forests on formerly non-producing land and yield important quantities of pulpwood and saw timber.

In this connection machine-planting of trees, under favorable circumstances, has markedly reduced the cost of plantation establishment, particularly where scarcity of man-power leads to high labor costs. It has at the same time greatly speeded up the rate at which planting can be accomplished, as compared with hand-labor methods. The same applies to the use of mechanical equipment in forest nurseries. It is true that such mechanized operations are not suitable for all locations, but the savings are so marked that careful trials are justified to determine, under any given set of circumstances, whether or not such methods should be adopted.

Essential in efforts to extend the forest area through planting is, of course, the supply of seed of suitable geographic origin and, where possible, of superior parent trees. To foster the international exchange of such high quality seed, the Conference of FAO, the governing body of the Organization, has approved uniform certificates of origin and quality, as well as a standard consignment form for international shipment. The Organization has also inaugurated a seed exchange clearing-house service which includes the issuing of an annual Forest Seed Directory listing suppliers, both governmental and commercial, and the tree species whose seeds they are prepared to exchange or sell.

Forest plantations may be started on bare land to extend the productive forest area, or planting can be carried out on cut-over, burned-over or eroded forest land: similarly reseeding and other measures can extend the productive area of forest grazing land, either land not producing to capacity or which has deteriorated as a result of misuse. Examples of such successful restoration can be cited from a number of countries. In Canada, for instance, range seeded to crested wheatgrass (*Agropyron desertorum* and *A. crist*[illegible] yielded four to six times more grazing than uns[illegible] depleted range; in the United States, extensiv[illegible] ing has resulted in increasing forage on the seeded a[illegible] from three to ten times. Of course, such successes i[illegible] these and other countries have been accomplished only by intelligent choice of favorable sites, adapted species, proper methods of crop establishment, favorable seasons for seeding and, particularly, the proper grazing management of the seeded stand.

Other measures tried with success include transplanting of grass tufts (Bermuda grass — *Cynodon dactylon* — and other rhizomatous grasses lend themselves to transplanting) and seedlings of fodder trees and palatable shrubs from nurseries, and in this connection methods developed by foresters in Morocco might well be copied in other like areas. Use of fertilizers has also greatly increased yields of forage per hectare in widely different parts of the world. Another important measure is the control of undesirable range plants such as thorn scrub (*Acacia* spp.) and mesquite (*Prosopis juliflora*); methods which have been successful include burning under carefully controlled conditions, mechanical treatment, chemical applications, and biological methods. Examples of the latter include introduction of insects to attack cactus (*Opuntia* spp.) in Australia, South Africa, and Hawaii, and St. Johnswort (*Hypericum perforatum*) in Australia and the United States.

Insect and rodent pests are important in some countries, and control may be essential if forest grazing areas are to be protected from serious damage. Locusts, grasshoppers, crickets, ants, rabbits, gophers, and mice have been brought under control by methods which have been developed after careful research.

Making undeveloped forests accessible: The considerable volumes of timber assessed at present as non-utilizable, because of physical or economic inaccessibility, could yield useful supplies to both local and foreign markets. Research is daily extending our knowledge of the properties of the wood of the species occurring in such forests, but this kind of research and testing needs to be expanded, whether carried out by governmental agencies or private industry. Armed with such information, trade promotion associations can do much to educate buyers and consumers to use hitherto little-known species. Standardization of nomenclature and descriptions, and adoption of uniform grading rules are other essential aids to successful promotional efforts.

Much interest is now being shown in a number of countries in the possibilities of the local resources for pulp and paper manufacture. Obviously, where the prospects are found to be economically sound, a demand for pulpwood for local manufacture into such high-value products as pulp and paper would mean a great deal in unlocking undeveloped forests. Proof that various species were suitable to make fiberboard or chipboard for housing and construction would also have a similar effect. As pointed out, the development of new wood-using industries of this sort must fit within the framework of the forest policy of the country.

The availability of the raw material can also be influenced greatly by modifying the physical accessibility of the resource. This involves mainly the develop-

(*Continued on p. 122*)

[2] *Les Eucalyptus dans les reboisements*, (FAO Forestry and Forest Products Studies No. 11, Rome, 1954.

Forestry and the Co

CHILE

Advanced erosion or canker of the soil resulting from deforestation. The soil is the prime resource of the world as we know it. We endanger or destroy the soil at our peril — any policy of land use must be synonymous with soil conservation and be in conformity with basic principles of soil use. Foresters alone cannot be expected to formulate such principles. Forestry, despite the many utility values and services of the forest, is only one form of land use. But foresters should certainly have a say in framing principles of this kind in view of the vital contribution that forested areas and forest range zones make to soil conservation, the halting of accelerated soil erosion, and regulation of streamflow.

✶

COSTA RICA

A farmer [*right*] takes fuelwood to San José market by solid-wheeled oxcart. Community and farm woodlands or trees in hedgerows, windbreaks or shelterbelts can be a great asset to farmers and villagers especially in relatively poorly forested areas. They can supply timber and fuel for local consumption or provide a supplementary cash income. They reduce the temptation to cut timber illicitly in forest reserves or on critical watershed areas.

✶

CHINA

Near Canton, a laborious method of cutting thin boards from small-diameter logs — all that are available — using a two-man hand saw. Sawing methods, older than recorded history, are now being subjected to careful study. Mechanization alone is not always a clear road to greater efficiency. Skilled management, good maintenance facilities, and properly trained workers are as essential as suitable tools and machines in most mechanized operations.

✶

mon Welfare

MALAYA

Extraction by sled in central Malaya. Dipterocarp logs must be cut to short lengths to permit their being manhandled. Similar practices are common in the Amazon forests of Brazil and in equatorial Africa. Tractors and other modern equipment make it feasible to remove larger and heavier logs difficult or impossible to handle with hand or animal operated equipment, thus improving utilization and opening up new areas for management. Better tools and machines are steadily remaking forest harvesting procedures with resulting economies and reduction in waste.

✶

INDONESIA

Village children in Java [*left*] gather fuelwood from a teak plantation being clear-cut in preparation for another rotation. Pressure of population and the heavy demand for both food and wood for fuel and timber lend attraction to the system whereby villagers cultivate land for a number of years, and in return plant and tend tree species which will ultimately form plantations. In 1952 an area of 43,000 hectares in Java was put to cultivation under this *taungya* system; over half were planted up with teak. This is a method of turning shifting cultivation to good account without causing either soil deterioration or the impoverishment or total disappearance of the forest.

✶

JAPAN

Fifty-year-old *Cryptomeria japonica* in Northern Honshu clear-cut in small patches. The area will be planted with seedlings the following year. The bark has been peeled from the felled trees for use as roof shingles. Because land is a scarce commodity in Japan, it is essential that good silviculture and management practices be used on the areas that can be allocated to forestry. This may, in the public interest, require the regulation of timber cutting on private lands or technical control of such cutting by competent professional foresters.

✶

nent of road networks, preferably as part of a general transport plan for opening-up areas not only to the extraction of forest products but also of other products such as minerals and in some circumstances farm products. In addition to road and also waterway development, the design and trial of mechanical equipment for logging warrants increasing attention, as is discussed in a subsequent paper. It is only necessary to point out here that manufacturers of such machinery need to be encouraged to develop really efficient equipment to meet special local conditions. Along with this, there is much to do in training forest workers and in improving their housing and living conditions, as already pointed out, so as to attract and hold the necessary manpower to open up new forest areas.

Improving management

The finest system of organizing forest land for continuous production is doomed to failure unless effort is also directed to the development of satisfactory techniques for the culture and protection of the crop. This problem will continue to demand the utmost in the skill, knowledge and imagination of foresters in finding the solutions for widely varying conditions. For much of the world's forest area is still without scientific management worthy of the name and even in areas advanced in forest production techniques, opportunities for further improvement are always present.

In Europe and those parts of Asia, for example, where the art of forest management has been long practised the intensification of thinning practices, more satisfactory methods of reproduction, proper control to obtain desirable species mixtures, conversion of coppice to high forest, better soil management, and the use of better seed and stocks produced by selection and breeding are among the many devices promising to raise yields in substantial degree. In Denmark, for example, where yields have risen under the most intensive management and protection to 10 cubic meters per hectare, exclusive of heath and dune areas, it is estimated that over the next 25 years improved silvicultural practices may raise total yields as much as 50 percent more. Similarly, care in stocking ranges with only the number of animals compatible with the capacity of the land to feed them properly, the reseeding of inferior ranges to better grasses, eradication of poisonous and other undesirable vegetation, improved water facilities, use of fertilizers, rotation of grazing and fallow areas and similar practices promise to accomplish the same objective with range productiveness.

In those substantial areas of the world where silviculture and other forest management techniques are on the whole undeveloped or in early stages of formulation, improving forest management for increased productivity involves several related major problems. One important problem is how to bring about the conversion into productive forest of old growth forest in which the net increment of sound wood is very low or balanced by loss and decay. Such conversion with a minimum loss in time and productivity, without wasting the wood already produced under natural conditions, is one of the most difficult problems with which foresters are faced. A second is the rehabilitation, by improvement cuttings and similar means, of forests culled or cut-over in commercial logging operations with little or no attention to silvicultural requirements or future productivity. The desire for immediate profit, coupled with indifference as to the fate of cut-over land or ignorance as to its potential value in wood production, has turned millions of hectares of forests into areas of low productivity. A third is the working out of suitable silvicultural practices for important forest types suitable for long term, sustained yield management, including methods of harvest cutting to assure natural regeneration, and methods of clearing, weeding, pruning and thinning to improve rate of growth and quality. This requires considerable knowledge of environmental conditions and silvical characteristics of the principal tree species, including seeding habits, seed bed requirements, the factors affecting initial seedling survival and development, response to competition, hardiness and numerous other factors of this kind, plus the ability to synthesize available information into a workable silvicultural system.

Lack of knowledge is often the major bar to adequate progress in solving this and the preceding problems cited. Here properly conducted forest research offers a powerful tool and desirable short cut to the expensive and time-consuming trial and error methods of the past. It is for this reason that forest research has long been a prominent activity in many advanced countries as is shown in FAO's study *Research in Forestry and Forest Products*,[3] prepared in co-operation with the International Union of Forest Research Organizations, which lists the current work under way at leading institutions in member countries.

Obviously the development of sound practices will require the accumulation of knowledge over a wide field, and its interpretation and synthesis into practical cultural and harvesting methods. The available tools include careful observation and study of ecological factors, intelligent observation and interpretation of past and current practice, and research over a wide field aimed at filling gaps in available knowledge as quickly and as inexpensively as possible. This requires proper organization and working conditions and the existence of a suitable body of professionally trained men well based in the fundamental sciences, forest management techniques and research methods. Increasing attention must be given, therefore, to the creation and strengthening of schools at the professional, ranger and guard levels. Such professional aid and guidance is often made available through government agencies or in some cases by the bonding together of small owners, whose properties are not large enough to bear such expenses alone, into co-operatives.

Reducing waste

One of the most direct contributions to forest productivity can be brought about by reducing the losses in wood already produced. Much progress has already been made in reducing losses from fire, insects and disease, but by and large these agencies still take a toll from both forests and manufactured forest products that often exceeds the amounts used to satisfy human needs. Here again education, both public and professional, good organization and adequate knowledge

[3] *Research in Forestry and Forest Products*. FAO Forestry and Forest Products Studies No. 9, Rome, 1953.

intelligently and energetically applied are the keystones to satisfactory action. Much progress has been made in fire prevention and control, the fundamentals suitable for application on a world basis being summarized in FAO's study *Elements of Forest Fire Control*.[4] Careful studies of forest insects and fungi on a local or regional basis have laid the groundwork for reducing or controlling losses from these destructive agencies, and new chemicals and toxicants are furnishing effective assistance in this never ending struggle. Genetics and selection are also beginning to play a part in reducing such losses by the production and propagation of immune or resistant hybrids or strains.

Similar opportunities for effectively increasing productivity by reducing or eliminating losses are common in forest utilization fields. Woods and milling operations are notoriously wasteful. Rarely less than 25 percent and too frequently 50 percent or more of the total forest crop is still lost in extraction and conversion operations. Here also research is basic to better practice and improvements in machines and tools: increased efficiency in harvesting and conversion operations; finding new outlets for wood fiber in pulp and paper products, fiberboards and chipboards; producing better preservatives and many other modern developments, discussed in more detail elsewhere, which offer promising tools for increasing productivity through waste reduction.

Summary

In addition to its fundamental protective functions, therefore, the forest serves an extremely important role as a producer of raw materials for industry and of consumer goods for direct use. Needs in forest products will certainly become greater, but competition between land uses is often severe as is also competition with substitute materials for wood and timber. Accordingly, if wood and timber are to play their proper part in the national economy, they must be of good quality and well adapted to industrial needs, as well as being as cheap as possible. Land must be used efficiently. This can be realized only if long-term forest policies are sound — which are also a condition for [illegible] stable forest industries.

A sound forest policy must, therefore, aim at satisfying as far as possible the national wood requirements of the country and its industries with due consideration to internal and foreign trade. One basic principle should be the greatest good, to the greatest number of people, in the long run. Sound forest policy, therefore, will take into consideration domestic requirements for food, fuel and primary shelter as well as industry and trade, and the need of land for other essential purposes, especially food. Other important considerations include the stage of industrial development and resultant demands on the forest, land ownership patterns, established rights or customs affecting forests, forest accessibility physically and economically, forest labor supply, present and potential domestic and foreign markets, the need of forest land for recreation and education, the size of the existing and potential forest resource and its productiveness, the possibilities of improving this productiveness by expanding the area through planting, by improved management and reduction of losses and waste. It is in relation to such factors that forest policy must be designed and the role and place of forested areas in the general land economy determined. From the standpoint of the productive function of the forest, therefore, the Congress may wish to consider particularly:

1. What determines the real needs of a given country for forest products and services?
2. In the light of such needs and related social, economic and technical factors, how does one determine the forest area needed and its proper role in the general land economy and economic development of the country? How does such evaluation vary under different conditions and circumstances?
3. How can forest policy, once determined, be translated effectively into legislative, organizational and financial support for forest administration, research and education?
4. What methods of improving forest and forest range productivity are most promising and how can they be best adapted to meet the needs and possibilities of any given country?

[4] *Elements of Forest Fire Control*, FAO Forestry and Forest Products Studies No. 5, Rome, 1953.

OXFORD SYSTEM OF DECIMAL CLASSIFICATION FOR FORESTRY

The authorized English version, prepared by the Joint FAO/IUFRO Committee on Bibliography in collaboration with the Commonwealth Forestry Bureau, Oxford, England, has been recommended by the Conference of FAO and the Congress of the International Union of Forest Research Organizations for adoption in member countries. Published by the Commonwealth Agricultural Bureaux, Central Sales Branch, Farnham Royal, England, on behalf of IUFRO.

Forest Products Utilization

THE countries richest in standing forests may be counted poor if they have no forest industries. To appraise the role that the forest should play in the economic development of a country and to gauge the relative position of forestry against other forms of land use, once the elemental needs for fuel and basic shelter and services have been met, it is necessary to make an assessment of forest industries, actual and potential.

And not just any forest industries, but efficient forest industries, because their end products must compare in quality and price, not only with competing substitutes for wood and wood-base materials but perhaps also with other products resulting from another form of land utilization.

But what are efficient forest industries? To deserve the epithet they should offer a high degree of encouragement toward good forest practices, particularly higher forest yields and more complete utilization of the forest crop; they must be backed by efficient harvesting, transport and manufacturing operations; they must ensure a satisfactory status for forest workers; they must be geared to take advantage of forest produce other than wood; and they must serve the development of key industries such as housing and paper manufacture.

With these criteria in mind the problem of improving forest utilization and developing satisfactory forest industries may well be discussed in relation to two interrelated objectives:

1. more complete use of the forest crop;
2. the production of useful and satisfactory goods at lower costs.

More Complete Use of the Forest Crop

In relatively few countries, outside western Europe and those nations with extremely limited timber supplies, does the forest crop contribute in anything approaching maximum degree to social needs. Even under the most intensive conditions of utilization there are usually opportunities for the reduction of waste or of conversion to more useful products. In many countries, and especially in tropical regions, entire forests are unmerchantable or unmerchantable except for a few choice species, while trees, of low utility, small dimension or unknown qualities cannot be harvested profitably. Logging and manufacturing wastes are often so high that larger amounts of wood are wasted, or burnt as low-grade fuel, than appear in the form of final products.

In general, these problems are more prevalent with broadleaf (deciduous) species than with conifers, for the occurrence of the latter in larger and less mixed stands and their qualities of reasonable strength with light weight, ease in seasoning and general workability, have made them eminently suitable for general construction purposes, which (after fuel) still offer by far the greatest single outlet for forest products. All of this is well known.

The problem of more complete utilization, then, is one of finding commercial outlets for species and sizes now unmerchantable, particularly for hardwoods, and for logging and manufacturing wastes of all kinds. This problem is not only important from the standpoint of better current use. It has important future implications as well, for often only through more complete utilization can stagnant or slow-growing old forests be converted to productive young growth with minimum waste; poor form or low-valued species be removed that might otherwise occupy growing space needed for better trees; and smaller trees harvested in the thinning and intermediate cuttings essential to the best silviculture and hence the greatest productivity and most efficient land use.

Under these circumstances it is only natural that a great deal of work should already have been done to extend our knowledge of unknown or little known species, and to improve the use of small size and low utility trees and industrial wastes. Much of this has taken the form of methodical and systematic research at leading forest products laboratories, forestry schools, museums and botanical gardens, and in the forest industries. The knowledge thus added on the anatomical, physical and chemical properties of new woods; the improvement of seasoning, preservation and pulping practices; and the creation of new products such as wood-based plastics, fiber and chipboards and numerous similar developments have helped substantially toward better and fuller use of the forest resource.

Only a few illustrations are needed as a reminder of the substantial and often spectacular changes that have taken place as a result of such past study and experiment. Sweet gum (*Liquidambar stryaciflua*), once an unmerchantable " weed " species of the eastern coastal plain of the United States, now ranks first among the hardwoods used from this area for furniture. Its tendency to warp and twist in seasoning was overcome by systematic study. Then the oaks, cedars, and other species of high natural durability were replaced on a wide scale with other less valuable and more abundant woods of suitable physical and mechanical properties for ties, poles and other uses requiring contact with the ground, once preservative treatment could be substituted for natural durability. Laminated timbers, once an engineering and architectural curiosity, permitting the employment of small dimension pieces, are now commonly employed in boat building and other construction requiring large timbers of high strength. Resinous pines, earlier considered unsuitable for paper making, are now used in substantial degree in the production of " kraft " and similar papers with the development and perfecting of the sulphate process. Hardwoods, already used in paper-making in rapidly increasing quantity (10 million solid cubic meters in the Unit-

ed States alone in 1951) are finding new outlets, as in the preparation of rayon and other dissolving pulps. In addition, new processes under trial, such as the semi-chemical pulping methods (chemigroundwood, cold caustic soda, neutral sulphite, sulphate semi–chemical) promise more widespread future use for hardwoods, including tropical hardwoods, as knowledge grows and the hard economics of pulp and paper production and marketing become more favorable. And those are only a few among the many illustrations that might be cited.

Perhaps the most spectacular and promising of recent advances are in the field of chemical conversion. To date the most substantial of these have been in the field of pulp, paper and plastics. Two rather new methods, hydrolysis and hydrogenation, give promise of extending even further the use of wood as raw material for the chemical industries. Hydrolysis, by changing wood into sugars, followed in some cases by conversion to other products, is a most promising approach to large-scale chemical utilization of wood waste. Wood molasses, industrial alcohol, high protein yeast, chemical solvents are all possible products of this process. Hydrogenation creates a complex of alcohols, phenolics and neutral oils, a possible mine of many useful chemical products such as solvents, fuels, lubricants, neutral oils.

Possible utilization of this kind is particularly effective in the use of wood waste, because chemical processing, though all too often a customer for roundwood, is best adapted to the consumption of wood of a great variety of forms or sizes or quality. Sawdust, shavings, slabs, trimmings, and cull logs are all suitable and, as has been stated, the amount of wood waste available is of such magnitude as to offer the basis for a great new chemical industry if even partially utilized. It is estimated, for example, that in the United States alone some 16 million tons of industrial wood waste remain unused each year with an additional 27 million tons burned as fuel in plant operations. Left in the woods each year are even larger quantitites of cut wood, too crooked, split or defective for lumber, but eminently suited for chemical conversion.

Forest products other than wood also offer a means of more complete use of the forest crop. Natural resins, such as oleoresin from pines or the so-called "wood resins" distilled from pine stumps, numerous tannins, essential oils, dyes and drugs offer a wide variety of supplemental products of utility and often high value. Here research has also proved a powerful tool. To take two illustrations among many: the distillation of "wood" turpentine and its refinement into a product competitive in quality and much lower in price than natural "gum" resin is one of the minor triumphs of industrial research. Conversely "bark" chipping combined with the application of strong acid to the wound or streak of turpentined pines is improving the competitive prospects of this material, and, by reducing the damage and degrading done to the valuable butt log of such trees is encouraging the extension of turpentining operations to stands heretofore barred to such practices. Dependable products in assured supply in respect of quantity and quality, and more efficient production at lower costs are often the keys to more complete utilization of minor forest products. Better collection and extraction methods and good marketing procedures are often especially important. In the case of medicinal herbs, for example, a better kno[illegible] the medically active substances and their phar[illegible]tical properties, combined with sanitary productio[illegible] standard quality and certain supply, would go fa[illegible] toward assuring forest producers additional substan[illegible]tial and sustained income.

Knowledge, then, and usually knowledge gained by research, is the key to more complete use of the forest crop. It should therefore be incumbent on each country to develop and maintain national or regional research facilities adequate to its needs, together with associated services for disseminating the knowledge gained to forest producers, manufacturers, engineers, builders, architects, and other key groups in the complex of forest utilization.

The information needed must cover a wide field. In less developed areas where untouched forests are still abundant and woods of great variety available, it would seem sensible and reasonable to begin with the basic information desirable for each tree species on botanical, anatomical, physical and mechanical properties. This information should ultimately include adequate data on the "engineering" qualities, such as specific gravity, bending and compression strength, hardness, shear, cleavage and toughness. The work of FAO's Technical Panel on Mechanical Wood Technology in the improvement and international standardization of these and related tests should prove of real value in this connection. But investigative work should also include study of "processing" qualities such as seasoning characteristics, decay resistance, and relative ease of preservative treatment, moisture absorption in use (shrinking and swelling), bending, weathering, gluing, nailing and painting properties, sawing and machining qualities and related information on color, figure, texture, grain, luster and so on. In general this knowledge, often acquired only through systematic and often prosaic but essential testing, will lay a proper base for intelligent use in producing structural timbers, lumber for construction, box boards, furniture, vehicles, mill work and so on, ties, sleepers and mine props, plywood and veneers, and those other outlets for wood which still use, aside from fuel, over nine-tenths of the forest crop.

Indeed it is obvious that some advanced manufacturing processes, the production of laminated beams, for example, are expedients forced by lack of suitable natural materials, in this case structural timbers of suitable size. Commonsense natural outlets should, of course, be sought first where the nature of the forest and the quality and variety of the species permit. A primary task will be the improvement or development of domestic or regional markets because wood is bulky and usually of low value per unit of weight. Ordinarily only wood products of exceptional quality and value will bear the cost of long distance shipping. Careful thought in this connection should be given to the proper development of industries serving the needs of the country's own people and commensurate with the degree of industrial development. It would seem unsound, for example, to emphasize the production of plastics at the expense of badly needed housing, or of industrial chemicals where chemical industries are primitive or undeveloped. In addition, it must be remembered that the more complex utilization processes, for example production of pulp and paper, plastics,

l rayon, often require considerable quantities of skilled and semi-skilled labor, trained technicians and a high degree of management skill not always readily available in less industrially developed areas.

Nevertheless a study of chemical properties, used here to include pulping qualities, should accompany other investigations at an early date. Chemical industries are not only a desirable supplement to the sawmill, plywood and other essentially "mechanical" industries (though a clear cut distinction here is obviously impossible) in offering new outlets — and especially outlets for smaller dimensions, waste, etc., with accompanying benefits in better silvicultural practice and increased productivity — but they also usually result in a product of higher value, permitting the utilization of more and on the average better paid labor, factors clearly in each nation's interest. A study of pulping qualities alone requires information on a considerable number of other properties ranging from chipping and grinding characteristics to the types of fiber and pulps, and the resultant papers that can be produced by various processes. Again research, usually both public and industrial, is the key to progress. FAO's Technical Panel on Wood Chemistry and Advisory Board on Pulping Tests have aided advances here by summarizing the latest information on processing woods and agricultural wastes and by suggesting procedures for international tests of new fibrous material for paper (FAO Forestry and Forest Products Studies No. 3 and No. 6, respectively).

In summary, then, more complete use of the forest crop will usually require more adequate knowledge of species and sizes now unmerchantable as a basis for developing desirable utilization outlets as economic conditions permit. As an essential first step, therefore, each country should see that:

1. its woods (and other useful plants and products of the forest) are properly identified and their qualities and available quantities reasonably well known; this will require adequate research facilities, national or regional, and reasonably good forest inventories;
2. accompanying extension services assure prompt dissemination of new and useful knowledge to forest producers, processors and users, including such key groups as engineers and architects;
3. proper extraction, processing and marketing facilities assure dependable products of desirable quality and utility in assured supply.

Useful Products at Lower Costs

Just how important in improving forest utilization is the production of dependable products of desirable quality and utility at lower costs? Obviously such production is a key factor, because the great technological and industrial advances of the last 150 years have placed wood in an extremely contested position where its usefulness and serviceability and its comparative price are of great importance. Indeed these technological advances have already robbed wood of many of its ancient markets. Once almost the sole fuel and one of the few primary materials for construction, wood has steadily been replaced in whole or in part by coal and petroleum and by a multitude of new construction materials, especially steel and cement. Metal beams and structural items, reinforced concrete, concrete bridges and piling, composition floors, steel furniture, all metal vehicle bodies, metal lath and window sash, metal doors and trim, composition roofing, make up only a very incomplete list of the items of this kind that could be cited. Many of these changes are in man's best interest and mark satisfactory social and economic advances. But too often they have taken place because the comparable wood product has become expensive or too scarce, or because it lacked adequate durability or, improperly dried or manufactured, failed for other reasons to give satisfaction in use. An additional factor has been lack of good advertising and marketing procedures, for too often wood has been left to "sell itself" against new and aggressive competition. It is obviously in a nation's best interest to see that these failures are corrected so that forest products and hence forest lands can be put to their best and fullest use.

It is also readily apparent that modern technology, while throwing formidable obstacles in the way of more complete use of the forest crop through the development of numerous competing materials, also opens innumerable channels for better use of the crop and its processing at lower costs.

New and better products

Some of the most interesting prospects for new and better products from wood, such as laminates, building boards, paper products and plastics, have already been discussed briefly in the section on more complete use of the forest crop. It will be sufficient to re-emphasize here that many of the difficulties in the traditional uses of wood have been due to bad manufacture, improper drying, lack of preservative treatment, and inadequate knowledge of its strength and other pertinent properties. Many of the prejudices against lumber will disappear as manufacturers improve the quality and serviceability of the product. As some writers have pointed out, it is highly desirable to select the right wood for the right purpose, a wood of good natural durability or satisfactory preservative treatment, for example, for use in contact with the ground; but equally undesirable to pay a price for qualities such as durability, where the use intended does not require this quality. Here the great variation in qualities between tree species should be a real advantage in wise use where knowledge is satisfactory. Organized demonstrational and educational effort is needed to focus the attention of the buying public on the merits of wood when properly selected and prepared. Too often builders, architects and other mass users know far too little about wood and discriminate to its disadvantage or use it unwisely, with ultimate prejudice on the part of the consumer. Better knowledge, properly disseminated, is here again the key to better utilization.

This knowledge has grown steadily in recent decades. Better knowledge of wood properties, improved methods of preservation and new preservatives, better paints, better glues, more adequate engineering information on strength, hardness, toughness, ability to withstand shear, new chemicals and treatment against fungi and insect attacks, increased fire resistance — all of these and many similar factors have and are receiving current

study. A successful fire-resistance treatment, for example, or a practical method of preventing shrinkage and swelling in use, both technological possibilities, would go far to regaining lost markets and insuring customer satisfaction. But this is only a beginning. These advances must be perfected and extended to unused or little used species.

In addition, engineers must take full advantage of the qualities inherent in wood as a structural material — high strength per unit of weight, non-conductivity, good impregnation qualities, workability, varying combinations of strength and other useful properties — all factors capable of withstanding strong competition in world markets. Research must show the way to radical improvement in wood construction. One major step has already been taken in the development of machinery and methods for the production of prefabricated houses. It is hoped that the factory methods thus permitted may shave 10 to 20 percent off the price of conventional houses, with an end product at least as good, if not better, insofar as the house-owner is concerned.

As previously stated, the chemist has already recognized the possibilities of wood as a raw material, and a new and brilliant array of useful products from this source is technically feasible; many are already in substantial commercial production. The future here is unpredictable. Solving the enigma of lignin alone, comprising approximately one-third of all wood substance, might well lay the basis for a great new chemical industry.

Lower costs

In addition modern technology offers innumerable ways of lowering costs through more efficient production and processing practices. Heavy machinery for road building, tractors for skidding and yarding, and trucks for more economical hauling have, for example, replaced skidders and railroad logging in many operations. New type cableways offer a means of harvesting isolated stands or stands in difficult terrain. Tractors and other modern equipment have made it feasible to remove the larger and heavier logs which are difficult or impossible to handle with hand or animal operated equipment, thus improving utilization and opening up new areas for management. In effect, new and better tools and machines of all kinds for cutting, skidding, loading and even unit bundling, or packaging of roundwood for ease in transport, are steadily remaking forest harvesting procedures, with resulting economies and reduction in waste.

One additional illustration will serve to indicate the methods and potentialities. The relatively new practice of skidding in tree lengths prior to limbing (crown removal) results in better utilization where the method is appropriate, permits more efficient limbing and power bucking at the landing and promises immeasurable benefits in regard to fire losses and fire protection costs by reducing the amount of dangerous logging slash left in the woods, heretofore an inevitable concomitant of harvesting operations except in regions of intensive utilization. The use of better tools and equipment and appropriate mechanization offers, therefore, rewards of great magnitude ranging from lower costs, particularly where wages are rising, t[illegible] harvest areas and species hitherto unmerchantable.

Even larger gains may be possible in processing field where better sawmills, improved equipment for planing and finishing; better glues and gluing processes including water-resistant synthetic resins; improved preservation methods, new chemicals to prevent staining, and new processes for the production of fiber and chipboards and innumerable paper products and derivates show the possibility of more effective utilization at lower costs.

The possibilities for savings and efficiency through the organization of integrated industries has already been mentioned. But new tools and machines, new methods of operation, and better arranged and mechanized plants offer less substantial but important efficiencies on all sides. Small sawmills, for example, have been greatly improved by the application of sound engineering principles, and portable mills are now available equipped with band or circular saws, lumber and slab conveyors, log ramps and edger.

Even sawing and chipping processes, older than recorded history, are now being subjected to careful study by new electronic devices, and the superior Reineke double kerf saw is only one of the new and useful devices that have appeared and will continue to appear out of ingenious and searching study of this kind in an infinite variety of fields. Here, again, research is the key to more effective progress.

Nevertheless, mechanization alone is not always a clear road to greater efficiency and reduced costs. Power saws, for example, very efficient under certain circumstances, as in log bucking at the landing or log yard, may be less efficient than normal saws in the woods. Mechanized pulpwood operations, permitting wood procurement at greatly reduced costs on suitable terrain and under skilled supervision, have failed miserably when these elements were lacking. Idle and improperly operated machines can be very costly. Small sawmills, of high technical and engineering qualities, may still turn out a low grade, poorly manufactured product if trained labor is unavailable or supervision inadequate. Indeed operations of this type may require good credit facilities and accompanying satisfactory seasoning, grading and marketing services, in addition to intelligent mechanical operation and maintenance, if they are to be truly satisfactory.

Any country contemplating mechanization, therefore, must remember that skilled management (proper organization and skilled supervision), good maintenance facilities, and properly trained and skilled workers are as essential as suitable tools and machines in most mechanized operations. And these items are often scarce or lacking in less industrialized areas.

Two items seem worth particular mention in this connection. Firstly, much emphasis has been placed in the past on the development of heavy equipment suitable for handling large logs, as on the west coast of North America or in tropical areas. This has been desirable and valuable. But much useful development and testing work still remains to be done in designing forest machines for managed forests, where, by and large, trees will not be grown to the great size and age found in virgin forests.

Secondly, the proper training of forest workers is obviously of special importance in modern forest oper-

ations. Although the training of workers in both the forest and processing phases is equally desirable, the training of woods workers offers some special problems because forest labor is usually scattered, often working alone or in small crews; it is commonly of two types: permanent forest workers deriving all or most of their livelihood from the forest, and part-time forest workers, usually farmers or seasonal workers. The work is of great variety, ranging from the use of simple hand tools to complicated heavy machinery such as tractors and skidders, and specialization is not always practicable, especially in small operations. Regional training centers and mobile forest schools, financed by government or industry, have been the main answers so far to this difficult question. Some twenty-nine schools for forest workers in western Europe alone are listed, for example, in a European directory of research and training institutions in this field compiled by the Pilot Committee on Logging Techniques and Training of Forest Workers of FAO's European Forestry Commission. The importance of forest worker training as a means of better production at lower costs with resultant improvement in the social status and standard of living of workers in the forest and related industries is obviously a matter well worth thoughtful consideration and action by government and industry alike.

Summary

In summary, then, modern technology while it has created many problems by the invention of wood substitutes, also offers innumerable channels through which efficient forest industries can be developed. Part of the solution lies in more complete use of the forest crop, for at present entire forests are unmerchantable, or unmerchantable except for a few species, especially in tropical regions, while almost everywhere logging and manufacturing wastes are high, and trees of low utility, small dimension and unknown qualities cannot be harvested profitably. In addition, wood as a raw material is in an increasingly contested position, and products giving adequate satisfaction to the consumer, at reasonable cost and in adequate supply, must be assured.

Modern technology has already made substantial progress toward more complete use of the forest and the production of satisfactory products at lower costs but much more remains to be done. A great deal more knowledge is needed on the properties of tree species not now merchantable and on how these and other species may be harvested more economically and processed more efficiently. Research has proved to be a powerful tool in obtaining such knowledge and it will pay each country to look at its national and regional research institutions to see that they are adequately equipped, staffed and financed for the task ahead. With the necessary basic knowledge in hand, and with accompanying extension services to assure prompt dissemination of new and useful information to forest users and processors, modern techniques offer brilliant prospects in more complete and better use of the forest crop. New machines for harvesting, and new processing equipment, methods and products, all promise broader utilization of wood as a raw material and its continued and efficient use in such key industries as housing and in pulp, paper and plastics. Indeed research now under way, especially in chemical fields, promises even further advances in the next few decades in the broadening use of wood as a raw material for key industries. Such use will not only create the employment and wealth inherent in manufacture and trade but assure more efficient use of a basic and renewable land resource, the forest.

The Congress might well consider, therefore, among other questions:

1. What steps need to be taken to assure more complete use of the forest crop, and its efficient harvesting and processing into useful products, competitive in price and utility?
2. How adequate is existing knowledge and the research and extension agencies necessary to obtain, improve, and disseminate such knowledge?
3. What are the prospects in each country and under varying circumstances, of broadening existing or creating new and useful forest industries appropriate to the country's needs and its domestic and foreign trade?

TROPICAL WOODS

The periodical *Tropical Woods*, devoted to the promotion of forestry in the tropics, is again to be published by the Yale University School of Forestry on a regular basis. Information may be obtained from the Editor, *Tropical Woods*, 205 Prospect Street, New Haven, Connecticut, U.S.A.

Forest Resources of the World

In 1953 FAO carried out a second world forest inventory. The preliminary results are summarized in the following article which also indicates the scope and limitations of the inventory, and some of the principal problems encountered. The detailed results will be published shortly under the title "The 1953 World Forest Inventory." The final figures will show some slight changes as compared with the figures quoted below, since several important returns have not yet been received, so that the data included below in respect of those countries may be several years out of date.

A SOUND national forest policy aims at the rational development and exploitation of forest resources on the principle of the greatest good for the greatest number. To formulate such a policy as precise a knowledge as possible of the wood resources of the country is required. These data a forest inventory must provide. To furnish all the elements necessary for policy formulation, the inventory should yield information on the forested area, ownership, composition and management status, as well as estimates of the volumes of standing timber, annual growth, fellings and removals.

Two factors give rise to the need for world-wide inventories. First, the population of the world is increasing steadily, on average by one and a half percent annually; forest resources, on the other hand, are in the short term relatively fixed, at any rate in extent. On a world scale efforts are necessary to ensure that forest output rises commensurately with world needs. Secondly, forest needs are by no means co-terminous with forest resources, since the factors which determine forest distribution transcend political boundaries. Hence the need arises for the co-ordination of national forest policies. In other words, the peoples of all nations and regions are becoming increasingly conscious of their interdependence, of the existence of "one world."

FAO is alive to this, and not only because the forests are a repository of important raw materials, but also because they play a decisive role in agricultural economy, by protecting crop lands and regulating the water regime. Thus a knowledge of the world's forest resources is vital to the execution of the program of FAO in its broader aspects, and not merely to that of its Forestry Division alone. It was for these reasons that FAO, at the second session of its Conference in 1946, decided to undertake an inventory of the forest resources of the world, asking all member countries to supply their most recent available data. The results of that enquiry were published in *Unasylva*.[1]

Clearly this kind of enquiry must be repeated at intervals. Forest area and output can be modified, the economic conditions of exploitation change with improved transport facilities, with technical progress in both extraction and utilization, with the utilization of hitherto non-commercial species and with the growth of population; moreover national statistics are steadily improving. Thus not only are forested area, growing stock, growth and fellings constantly changing; so is the accuracy with which they are measured. Hence periodical reviews are necessary, and for this reason the sixth session of the FAO Conference, in 1951, recommended that the organization should, at five-yearly intervals, collect and publish available information on the forest resources of the world, the next inventory to be undertaken in 1953.

Following this recommendation, experts met in Geneva in 1952 to consider definitions and determine the scope of the 1953 inventory. Forms were agreed and despatched to all member countries, including dependent territories. At the same time FAO staff gathered information from both official and unofficial sources concerning the resources of non-member countries.

Of the 212 countries and dependent territories which may be distinguished, 12 have a land area of less than 10,000 hectares, while 44 have a forested area not exceeding 10,000 hectares.

Responses to the 1953 questionnaire, together with the results of the first inventory, supplemented by data collected with the aid of authorities in member countries, official reports, and FAO Technical Assistance field experts, have made it possible to assemble data, especially concerning forested area, in respect of 198 countries. In the remaining 14 countries and territories forests are either non-existent or negligible in extent. Thus the 1953 Inventory provides the most comprehensive picture of the extent of the world's forests which has so far been published. The sources of the information included are set out below in Table 1.

TABLE 1. – DETAILS OF INFORMATION SOURCES

Source of information	Number of countries	Percentage of world forested area
Replies to 1953 questionnaire	109	69
Replies to 1947 questionnaire	12	3
Official statistics	71	27
Unofficial reports	6	1

No attempt has been made to compare the 1947 and 1953 inventories, since no valid comparison is possible. Apart from changes in definition,[2] there are many other facts which invalidate a comparison. For each world inventory, countries report the results of their most recent national inventory. Some countries, including several with important forest areas, have made no new inventory since 1947; thus the changes which have taken place there in the last seven years have not yet been recorded. Moreover, many countries

[1] See "Forest Resources of the World," *Unasylva*, Vol. II, No. 4, 1948 and Vol. IV, No. 2, 1950.

[2] A short account of the principal changes is given later in this article; a full discussion will appear in *The 1953 World Forest Inventory*.

which had suffered during the war were unable in 1947 to estimate accurately the effects of overcutting and forest destruction, and could return only provisional figures: the increase in precision which their more recent figures afford overshadows the real changes which have taken place. The statistical service in many countries, especially in the less developed regions, has improved out of all recognition in recent years.

Finally, in the overwhelming majority of countries, even to-day, there has been no complete inventory, but only estimates based on partial inventories. Thus for the world as a whole, and for most individual countries, the differences between the figures reported in 1947 and 1953 reflect primarily improvements in statistical coverage and accuracy; it is therefore quite impossible to draw firm conclusions about real changes which have taken place in the forests. Some of these factors are transient, deriving from special difficulties experienced in the immediate postwar period. The steady progress now being made, together with increasing uniformity in approach and clarity in definition, offer the hope that valuable conclusions may be drawn when the results of the 1958 inventory are compared with those of the current one. The 1947 inventory was largely experimental. The pattern of future world inventories is not likely to depart substantially from that established in the 1953 inventory.

A world inventory cannot provide answers to all the questions which a national inventory must pose. It can afford indications of the extent of the world's forests, and of the wealth of resources they contain. It cannot ascertain whether the forests are well distributed for fulfilling their productive and protective role; it cannot hope to afford a comprehensive picture of age and species distribution, or to reflect the effects of silviculture on the quality of output. These, and many other questions, a national inventory will seek to answer. They are not appropriate to a world inventory, which must confine itself to eliciting a limited range of salient facts.

Information sought

The experts who designed the 1953 questionnaire had to find an acceptable compromise between the need to preserve continuity with the earlier inventory and the need for modifications arising from past experience and from the very real progress which has been achieved in national forest statistics in recent years.

The 1947 inventory had demonstrated clearly that the distinction drawn therein between productive and unproductive forests was an arbitrary one; many countries found it impossible to submit reliable information classified in this way. For this reason, the primary classification in the 1953 enquiry is into accessible and inaccessible stands, the former category including, but separately distinguishing, " unexploited, but accessible " stands. For similar reasons, the more detailed information required in 1953 relates only to " forests in use "; in 1947 it related to all accessible productive forests.

Because the inventory in 1953 concentrates on forests in use, which are fairly well-documented, and because of the considerable progress made in forest statistics since 1947, it was decided to collect several important categories of information which did not appear in the earlier inventory, e. g. concerning the present status of forest management (area of forest under working plans, cutting practices, allowable cut). To clarify the distinction between fellings and removals, questions were asked about logging and floating losses. A separate section deals with roundwood supply from trees outside the forest, of considerable importance in many countries, particularly in Europe and the Mediterranean basin. A further new section dealt with changes in forest area (inaccessible forests becoming accessible, afforestation, losses to other land categories), all factors influencing future roundwood supply. Thus the 1953 inventory includes information falling into the following main groups:

forest area in relation to other land categories;
forests in use: management, standing timber, growth, fellings and removals;
accessible forests: yield and ownership;
other roundwood sources;
changes in forest resources.[3]

The definitions which had been adopted in the 1947 questionnaire leaned too heavily on the experience of advanced countries, where the agricultural and forested areas are distinct and where the forests have for the most part long been under rational management. They were not always valid for less developed countries, nor did they allow for some important differences in concept which exist even among the advanced countries. Accordingly the 1953 questionnaire contained revised definitions, and made provision for detailed explanation by countries of the ways in which their own definitions differed from those set out.[4] Nevertheless certain difficulties arose, and a brief account of some of the more important ones may not be out of place since it throws light on the problems attached to the taking of a world forest inventory.

Forest is defined as land bearing vegetative associations dominated by trees of any size. But in many parts of the world — in Africa, for example — dense forests shade off into open stands with a continuous sheet of grass, finally passing into shrub and thorny formations. Where does the forest end and brushland begin? The answer to this question frequently depends on local administrative convenience, so that areas classified as forests may in fact bear only a few small and deformed trees per hectare, along with scattered thorny shrubs of no economic value. Grazing grounds, whether grazed by wild or domestic animals, if they occur within the forest area are more often than not classified as forest, since they usually come under the supervision of the forest administration. Thus the term " forest " in this inventory covers stands of very different densities. Shifting cultivation — the alternate use of the soil for forest and agricultural crops — presents another problem; some countries classify these lands (which are subject to burning and clearing on an indefinite rotation) as forest, others as brushlands, and others as agricultural land. Because shifting cultivation is important in many parts of the world, a future inventory will have to pay special attention to this problem.

[3] Not discussed in this article.

[4] Space does not permit the inclusion in this short article of the statistical qualifications which attach to the individual and summary figures quoted below. In *The 1953 World Forest Inventory*, all figures are annotated in detail.

Accessible forests are defined as forests within reach of economic management or exploitation. But the accessibility of a forest depends not only on transport facilities and communications; it depends on cutting practices and on the product sought. A forest may be accessible for fuelwood extraction by the inhabitants of a remote village, but inaccessible for exploitation on a significant scale for industrial wood. A handsawyer may work where modern mechanical equipment cannot penetrate. Thus accessibility is an arbitrary as well as a transient concept (though presenting fewer practical difficulties in arriving at estimates than did the earlier concept "productive forests"), and this has to be borne in mind in interpreting the results of the inventory.

Evidence of differences in national practice was perhaps most striking in the methods of calculating the volume of standing timber in forests in use; these differences, of course, applied equally to estimates of growth and allowable cut. In extreme cases only trees over 40 years old or over 40 cm. diameter at breast height were included. Some countries included, others excluded, tops, stumps and branches. Table 2 indicates the practice followed by the 57 countries which were able to give full details:

TABLE 2. – ESTIMATE OF GROWING STOCK

Type of growing stock	Number of countries	
	Including in estimate of growing stock	Not including in estimate of growing stock
All trees in the forest	30	27
Branches	10	47
Tops above merchantable diameter	23	34

A few examples will illustrate the divergency in practice. In Belgium, the volume of growing stock excludes spruce and Douglas fir under 30 years old and other conifers under 20 years; in Sarawak, all fuel trees are included but timber trees of less than 50 cm. diameter are excluded; in Sierra Leone, branches of trees yielding industrial timber are excluded, but those of trees used for fuel included. These examples serve to emphasise the danger of drawing international comparisons from reported figures without paying careful attention to the exact meaning of the figures reported. A further complication is that felling and removal statistics often include trees or parts of trees excluded from standing timber and growth statistics, weakening any comparison between net growth and fellings, a relation vital to sustained yield management.

Whereas in Europe and North America and in certain countries in other regions all forest species are marketable, in many tropical and sub-tropical forests only a limited number of species has any commercial value. Extraction is selective, and the bulk of the growing stock is left in the forest, some to be used ultimately as fuelwood, but most to rot. Species not to-day marketable are frequently left out of account altogether in national estimates of growing stock, growth and allowable cut. Here again not only are international comparisons invalidated: the relationship between growth and removals becomes meaningless, especially [illegible] locally used fuelwood may appear in felling sta[illegible] while excluded from growth figures. Hence the [illegible] that in Liberia, for example, fellings are roughly doub[illegible] net growth does not necessarily mean that there [illegible] evidence of overcutting, since the two categories of information are not statistically comparable.

Bark presents another problem, since here again practice differs widely. The difference which the inclusion or exclusion of bark can make may be appreciated when it is realized that, according to species and diameter, bark may account for anything from 5 to 50 percent of standing timber volume. On the basis of information submitted by countries or collected by the FAO staff from various sources, an attempt has been made to present some of the published figures in a form capable of bearing international comparisons. Thus figures of growing stock, gross increment, natural losses, net growth and allowable cut are presented with bark; figures of annual cut, logging and floating losses and removals are presented without bark. In Table 19 which presents the relationship between net growth, allowable cut and fellings, however, all figures are presented on a without bark basis. The procedures adopted to secure comparability are described in detail in *The 1953 World Forest Inventory*.

Finally, it has to be borne in mind that in many countries where the forest service is not highly developed the official statistics relate only to recorded fellings. These may be only a fraction of total fellings, including illicit cuts. Frequently estimates of unrecorded fellings, based on sample enquiries, have been made; where available these have been included. For many countries, however, unrecorded fellings have necessarily been excluded. The significance of this aspect of the published figures will be recognized by those who appreciate that unrecorded and illicit fellings have been largely responsible for the destruction of forests in the past.

This short and by no means exhaustive account of some of the problems encountered in compiling the 1953 world forest inventory leads us to two important conclusions. First, it is necessary to exercise extreme caution in interpreting the published figures, especially in drawing international comparisons and in relating growth to drain. Secondly, in spite of the considerable progress made in forest statistics in the last seven years, we are still very far from the goal of comprehensive, systematic and comparable statistics relating to the world's forest resources.

Response

The present state of knowledge about national forest resources is brought out clearly by the figures set out in Table 3.

All or nearly all the 110 countries completing the 1953 questionnaire were able to provide information relating to the forest area, afforestation and removals; about two-thirds furnished data relating to growing stock, fellings and areas lost to other land uses; less than half could give figures for net growth. For allowable cut, a figure of the highest importance for forest management on sustained yield principles, only 42 countries were able to provide an estimate.

It has to be remembered that national forest inventories are a comparatively recent innovation, though

TABLE 3. – COUNTRIES REPORTING ON NATIONAL FOREST RESOURCES

Region	Number of countries reporting	Number of countries providing data relating to: Forest area	Growing stock	Net growth	Allowable cut	Fellings	Removals	Afforestation	Lost areas
Europe	21	21	19	19	17	20	21	21	19
North America	3	3	3	2	—	—	3	1	—
Latin America	21	21	9	4	4	12	21	14	10
Africa	31	31	15	12	7	17	31	27	22
Asia	24	24	18	15	14	16	24	23	14
Pacific Area	9	9	5	1	—	4	7	8	2
TOTAL	109	109	69	53	42	69	107	94	67

— Nil.

inventories of individual forests as a recognized basis of forest management have been taken in various countries for almost a century. Thus many countries which do not have basic information on a national scale, nevertheless possess comprehensive figures for some of their more important forests. On the other hand, even in countries where comprehensive, nation-wide data are available, these figures are sometimes insecure, resting on partial inventories and on sample surveys whose scope has been limited by the funds available. Very few countries have been able to establish precise figures based, for example, upon a modern combination of air and ground survey techniques.

Moreover, Table 3 gives only the reporting countries' response to certain key questions relating to forests in use. Much less is known about inaccessible stands and accessible stands not yet exploited.

Some of the implications of the uneven response to the 1953 inventory are touched on at the end of this article, in the paragraphs headed *Conclusions*. In the sections which immediately follow, an attempt is made to summarize the data available for some of the more important categories of information. In each section, an indication is given of the degree of response to the corresponding questions. The degree of response, it should be noted, takes account not only of countries completing the 1953 questionnaire, but of all countries (including some non-member countries) in respect of which official data or reliable unofficial data relating to the particular category of information were available, whether or not questionnaires were completed and returned.

Forest areas

The regional distribution of the world's forests is summarized in the following table: details for more than a hundred countries and territories are presented in Appendix I: Land Categories.

TABLE 4. – DISTRIBUTION OF THE WORLD'S FORESTS

Region	Forests: Total	Inaccessible	Accessible: Total	Accessible: In use	Non-forested land	Land area	Forests as percentage of land area	Forest area per head: All forests	Accessible forests	Forests in use
	(million hectares)						(%)	(hectares)		
Europe	136	3	133	130	343	479	28.4	0.3	0.3	0.3
U.S.S.R.	743	318*	425*	350*	1 446	2 189	33.9	3.8	2.2	1.8
North America[1]	656	344	312	220*	1 160	1 816	36.1	4.1	2.0	1.4
Latin America	927	584	343	90*	1 315	2 242	41.3	5.5	2.0	0.5
Africa	801	519	282	115*	2 169	2 970	27.0	3.9	1.4	0.6
Asia	567	308	259	205*	2 133	2 700	21.0	0.4	0.2	0.2
Pacific Area	85	65	20	17	770	855	9.9	6.6	1.6	1.3
WORLD TOTAL	3 915	2 141	1 774	1 127	9 336	13 251	29.5	1.6	0.7	0.5

[1] Alaska, Canada and the United States.
* Figures including unofficial estimates.

Nearly 30 percent of the earth's land surface is under forests; a further 22 percent is devoted to agriculture. The rest, or nearly half, consists of natural grasslands, brushlands and unproductive areas.

Forests cover over two-fifths of the land area in Latin America, one-third or more in the U.S.S.R. and North America, slightly less in Europe and Africa, and less than one-tenth in the Pacific area.

The forest area per inhabitant ranges from 6½ hectares in the Pacific area down to 0.3 hectares in Europe.

The fact that woodlands (if we include brushlands with the forests) cover rather more than one third of the land area of the world might lead us to suppose that they are ample in extent both to fulfill their protective role and to ensure that the world's needs of forest products are satisfied. But within each of the main regions distinguished above there are important areas severely lacking in forests; and within individual countries there are areas of scarcity amidst apparent plenty. Most of the North and Latin American countries are well endowed, Uruguay being the only notable exception. But North Africa's 8½ million hectares of forest represent only 1.5 percent of the land area and 0.19 hectares per inhabitant. In the Near East area, only 0.9 percent of the land area is forested, representing 0.12 hectares per inhabitant. And though India and Pakistan between them have 73½ million hectares of forest, 17.3 percent of the land area, this gives only 0.17 hectares per inhabitant. Were separate statistics available, central and southern European Russia and central China would yield figures showing a similar dearth of forests. Even in southern Europe, the forest area per inhabitant amounts only to 0.26 hectares.

It is common knowledge that some of these areas which today are sterile tracts of desert or near-desert were formerly well-forested, green and fertile. Reckless annihilation of the forests has led to soil degradation and sterility, in some cases in quite recent times. The 1953 inventory affords some indications of the steps being taken today to conserve existing forests and to halt and reverse the relentless march of the desert.

Fifty-five percent of the world's forests, or 2,140 million hectares, are today classified as inaccessible. Only two-thirds of the accessible forests, or 29 percent of all forests, are today in use. The immensity of the resources yet untapped may be understood if we appreciate that, leaving aside the 1,130 million hectares today exploited, there is a first reserve of 640 million hectares accessible but not as yet exploited, and a second reserve of 2,140 million hectares not yet accessible. Finally, there are many areas of non-forested land better suited to forestry than to other land uses.

This bald summing-up, however, exaggerates the world's potential, since some of the unexploited accessible forest, as well as some of the inaccessible forest, has primarily a protective role and should not be brought into the reckoning as a future source of forest products. These areas, according to the 1947 inventory, probably amount to about 1,400 million hectares. That still leaves potentially exploitable reserves of about 1,400 million hectares, considerably more than the total area of forest exploited today, though here too it must be remembered that yields might be very low, and that wood in the rough cannot economically be moved over long distances.

The accessible forests not yet exploited a[illegible] mainly in Canada, Latin America, and Afri[illegible] following table shows the orders of magnitu[illegible] in certain selected countries:

TABLE 5. – UNEXPLOITED ACCESSIBLE FORESTS IN CERTAIN COUNTRIES

Country	Accessible forests: today in use (in 1,000 ha.)	Accessible forests: still unexploited (in 1,000 ha.)
Canada	66 580	63 590
Argentina	10 000	50 000
Brazil	30 010	90 040
Colombia	410	61 590
Ecuador	500	2 000
Mexico	4 500	20 060
Peru	5 000	10 000
Belgian Congo	5 300	9 700
Fr. Equat. Africa	12 030	15 020
Fr. West Africa	10 500	3 500

The inaccessible forests are naturally found in remote areas — in the colder zones of Alaska, Canada and the U.S.S.R., and in difficult parts of Asia and Latin America. The spreading network of communications which accompanies general economic development is rapidly enlarging the area of forest within reach of exploitation, and developments in modern logging techniques make necessary frequent reassessments of the concept of accessibility.

It has already been noted that only 29 percent of the world's forests are today being exploited. But whereas virtually all Europe's forests are in use, in Latin America less than one-tenth of the forest area is being exploited. It may seem surprising that only a third of North America's forests are being used but it must be borne in mind, as mentioned above, that protective forests account for a considerable proportion of the unexploited area.

Most regions of the world, then, have vast timber reserves which could be drawn on to satisfy the needs of the local populations. Nevertheless some of the best endowed regions still look today to Europe and North America for part of their supplies, as Table 6 shows.

TABLE 6. – ACCESSIBLE FORESTS AND TRADE BALANCE

Region	Accessible forests (in million hectares): in use	Accessible forests (in million hectares): not exploited	Net trade in forest products (average 1950-52) [a] (in million cubic meters roundwood equivalent)
Europe	130	3	+ 3
U.S.S.R.	350	75	+ *
North America	220	92	+ 6
Latin America	90	253	— 2
Africa	115	167	— 2
Asia	205	54	— 2
Pacific Area	17	3	— 3

[a] + net exports; — net imports.
* Negligible.

Economic growth in Europe and North America has favored intensive silviculture and the establishment of highly developed wood converting industries. In the less developed regions of the world conditions for these developments have hitherto been lacking. But cultural and economic progress is giving rise to higher standards of wood consumption at the same time as it is creating the conditions for a fuller use of indigenous forest resources.

State forests and private forests

The different forms of ownership of accessible forests in the several regions are summarized in Table 7.

TABLE 7. – OWNERSHIP OF ACCESSIBLE FORESTS

Region	Degree of response[a]	Forms of ownership (percentage in each category)			
		State forests	Communal forests[b]	Owned by institutions	Private forests
Europe	100	32	13	1	54
U.S.S.R.	100	[c]100	—	—	—
North America	100	49	2	*	49
Latin America	43	62	1	1	36
Africa	85	74	22	*	4
Asia	84	86	2	*	12
Pacific Area	82	76	*	—	24
TOTAL AVERAGE	93	73	5	*	22

[a] Area of accessible forest for which ownership data were reported divided by total area of accessible forests reported in region, expressed as a percentage.
[b] Includes forests reserved for the benefit of native tribes.
[c] Reported to include 41.2 million hectares, managed by collective farmers.
* = Negligible.
– Nil.

The response to this question was complete in the regions of the northern hemisphere, very low in Latin America and far from complete in other regions. It has to be remembered, however, that whereas in Europe, the U.S.S.R. and North America forest ownership has been progressively consolidated under the pressure of political, economic and social needs, elsewhere in the world the systematic determination of forest ownership has, for the most part, only started recently. In the less developed regions, especially in the remoter areas, considerable tracts of forest are unmapped, unsurveyed, and without established titles. Recognition of titles in the forest is a corollary of growing consciousness, public and private, of the extent and value of these resources; it is often a precursor of, and usually a prerequisite for, extended forest administration.

Nearly three quarters of the world's accessible forests are state-owned, and most of the rest are in private hands. Private forests are most important in Europe, where they account for over half the accessible forest area. In North America, too, nearly half the forests are in private hands. Only in Africa and Europe do communal forests assume considerable importance, the large figure for the former region being accounted for by the fact that forests reserved for the benefit of native tribes are included in this category.

Though any kind of forest ownership is suited to forest administration, it is clearly easier to ensure that sound principles of forestry are applied in practice in state-owned forests than in privately-owned forests. This is certainly the case where there is a multitude of private owners, each controlling tiny holdings; it is less true for large forest estates owned, for example, by industrial corporations. Some striking figures of forest distribution by size of holding are given in the following table:

TABLE 8. – DISTRIBUTION OF ACCESSIBLE PRIVATE FORESTS BY SIZE OF HOLDING IN SELECTED COUNTRIES

Country	Percentage of total accessible private forest area in holdings of various sizes			
	Less than 5 hectares	5 but less than 100 hectares	100 but less than 1,000 hectares	1,000 hectares and up
Austria [a]	15	51	13	21
Finland [b]	1	64	34	1
Ireland	25	60	15	—
Western Germany	[c]42	28	15	15
French Cameroons	—	—	60	40
Peru	—	—	20	80
Turkey	1	24	46	29

[a] Includes inaccessible forests; census 1935.
[b] Excludes forests owned by industrial corporations.
[c] Less than 10 hectares.
– Nil.

In Western Germany, 42 percent of the private forest area consists of holdings of less than 10 hectares. In Austria, Finland and Ireland holdings of less than 100 hectares account for two-thirds or more of the private forest area. At the other extreme, 80 percent of Peru's private forests consist of holdings of 1,000 hectares or more.

The multiplicity of small private forests presents a major obstacle to enlightened forest management in many countries, an obstacle which in some cases is being surmounted by the encouragement of forest co-operatives.

Composition of the forests in use

The distribution of conifers, non-conifers and mixed woods in the world's exploited forests is shown in Table 9.

For the world as a whole just over half the forest area today exploited consists of coniferous species. The conifers, however, are unevenly distributed, more than half the stands being found in the U.S.S.R. and less than one-tenth in the Southern Hemisphere. A cool temperate climate determines the natural occurrence of most coniferous species; hence they are found in a broad belt encircling the earth below the treeless tundras of the far north. They have only a limited occurrence in the continents of the Southern Hemisphere, since these land masses taper towards the south, hardly reaching into the true temperate zones.

TABLE 9. – COMPOSITION OF THE WORLD'S FORESTS IN USE

Region	Degree of response [a]	Area of forests in use (million hectares)					Estimated percentage of conifers [a]
		Total	Conifers	Non-conifers	Mixed-woods [b]	Open areas [c]	
Europe	100	130	66	49	12	3	59
U.S.S.R.	100	350*	300*	50*			85*
North America	100	220*	140*	80*			65*
Latin America	94	85	8	73	1	3	9
Africa	93	107	2	104	1		2
Asia	86	177	38	101	34	4	25
Pacific Area	94	16	2	14			13
TOTAL	96	1 085	556	471	48	10	53

[a] Area of forests in use for which composition data were reported divided by total area of forests in use in each region, expressed as a percentage.
[b] Mixedwoods and open areas are often included in the area of pure conifers and non-conifers. The total figures for pure stands are therefore over-stated and those for mixedwoods and open areas understated.
[c] Includes a reported allowance for conifers in mixed stands.
* Unofficial estimates.

It should be emphasized, and indeed subsequent tables will make it abundantly clear, that forest area is a very inadequate measure of forest wealth. The areas indicated in the foregoing table, both for coniferous and broadleaved species, include stands of very different densities and with very diverse rates of growth. Standing volume and growth per hectare in the northern parts of the U.S.S.R. are but a fraction of those in, for example, Chile; there are, in fact, very great contrasts even between northern and southern Sweden.

Broadleaved stands are much more evenly distributed, over a third occurring in regions of the Northern Hemisphere In Europe, North America and the U.S.S.R., they consist almost entirely of temperate hardwoods; elsewhere, tropical hardwoods dominate the scene, temperate species being found only in higher altitudes and tatitudes.

The 1947 inventory indicated (subject to the statistical qualifications which have been mentioned earlier) that 36 percent of the world's productive forests consisted of conifers; for accessible productive forests alone it was 38 percent. Table 9 above, however, shows that conifers account for 53 percent of all forests today exploited. The difference between these figures reflects the fact that so far the coniferous forests have been better suited, either by quality or by location, to satisfying the demand for forest products. Hitherto broadleaved species, save for temperate hardwoods and some precious tropical species, have been mainly used as fuel and for charcoal; conifers have served a much wider range of human needs, especially for construction, transport, timber fabrication and pulp. Economic and cultural progress in the less developed regions is heightening the demand for forest products, and leading to progress in the development of their indigenous resources; in the long run this is bound to lead to an increase in the relative importance of broadleaved forests exploited.

Forest reserves, working plans and cutting practi

The conservation and rational utilization [illegible] resources calls for a comprehensive land use [illegible] that plan the forests have an integral part, taking into account both their protective and productive functions. This is true for all countries, whether possessing abundant forests or seriously lacking in forests. In the latter case, land will be reserved for afforestation; in the former case, perhaps only part of the forests will be classed as forest reserves.

This classification into reserved and unreserved forests is indeed the first step towards rational management, since the forest administration will concentrate its efforts on the reserved stands. Table 10 illustrates the stage reached in various regions in classifying reserved stands in the accessible forests.

TABLE 10. – RESERVED AND UNRESERVED FORESTS

Region	Degree of response [a]	Area of accessible forests (in million hectares)	
		Reserved	Unreserved or not yet classified
Europe	93	123	—
North America	100	312	
Latin America	49	1	162
Africa	61	77	95
Asia	56	84	60
Pacific Area	80	8	8
TOTAL	53	605	325

[a] Area of accessible forests in respect of which data concerning reservation was reported divided by total area of accessible forests in each region, expressed as a percentage.
— Nil.

Responses to this question covered 930 million hectares of accessible forest; of this area about two-thirds have so far been reserved as permanent forest. In Europe and North America, all the accessible stands are reserved. In Asia and Africa, about half the accessible stands have so far been reserved, while in Latin America progress has been negligible.

A national forest policy aims at managing the forests, whether reserved or as yet unclassified, according to the principle of maximum sustained yield. This is normally achieved by the establishment of working plans for smaller forest units, laying down management principles, allowable cut and silvicultural practice. Table 11 illustrates the progress made in various regions in establishing working plans; the last three columns afford an indication of the quality of current cutting practices.

Of the 500 or so million hectares of forests in use in respect of which this category of information was provided, less than one-third was under working plans. The proportion was over half in the Pacific Area, where the response to this question was high, and in Canada. Next comes Europe, with 42 percent, followed by Asia and Africa; for all these three regions the replies covered about three-quarters of the forests in use. There was

TABLE 11. – MANAGEMENT STATUS AND CUTTING PRACTICES IN FORESTS IN USE

Region	Degree of response[a]	Management Status			Percentage area subject to cutting practices described as		
		Area of forests managed with working plans	Area of other forests in use	Area of forests with working plans as % of forests in use	Good	Fair	Poor and destructive
		(in million hectares)			(in percent)		
Europe	76	41	58	42	65	30	5
North America[b]	30	36	31	54	..	..	..
Latin America	94	2	83	2	10	30	60
Africa	78	11	79	13	30	30	40
Asia	72	58	89	40	30	40	30
Pacific Area	94	9	7	54	40	30	30
TOTAL	45	157	347	31	35	30	35

[a] Area of forests in use for which data concerning management status were reported divided by total area of forests in use in each region, expressed as a percentage.
[b] Canada only.
.. Not available.

a good response to this question from Latin America, but it indicated a negligible proportion of forests managed with working plans.

The following figures for certain African and Latin American countries exemplify the rudimentary stage of forest management which has so far been attained in those regions:

TABLE 12. – STAGE OF FOREST MANAGEMENT IN CERTAIN COUNTRIES

Country	Forest in use (in 1,000 hectares)		
	Total	Managed with working plans	Others
Argentina	10 000	1 300	8 700
Brazil	30 010	400	29 610
Chile	6 595	—	6 595
Paraguay	5 020	—	5 020
Peru	5 000	—	5 000
French Equatorial Africa	12 030	1 875	10 155
Belgian Congo	5 300	200	5 100
Gold Coast	2 910	105	2 805

— Nil.

This state of affairs is the more to be regretted in that publicly-owned forests in Latin America and Africa make up 64 percent and 96 percent respectively of accessible forests; accordingly, it would seem easier here to bring these forests under working plans than in other regions such as Europe where the area of publicly-owned forest is relatively small and the total of privately-owned forest is often split up amongst a large number of petty owners.

Even in the areas where forests under working plans amount to almost 50 percent or more of the total forest in use, there is still much progress to be made. It would undoubtedly be too much to expect that every small woodland should be subject to a detailed management plan. All the same it would be definitely to the advantage of small owners to regulate the cut on their woodlands in some proportion to growth and to practise systematic silviculture. Even if silvicultural practices were good or average on even 50 percent of a country's forest area, the fact that the rest were not managed to take account of their potentialities in growth and new stock, could seriously jeopardize the continuity and value of any national forest policy.

Table 11 also includes data on prevalent cutting practices.[5] These are, essentially, "opinion" judgments submitted by national forest authorities; views of what constitutes good cutting practice vary from country to country, and regional averages have little or no meaning. The data submitted, however, are of considerable interest as indicating the views of the responding forest authorities on the present state of forest management within their own countries. Table 11 suggests that, in the view of the forest authorities themselves, only one third of the forests in use are exploited with due regard to the requirements of good silviculture, while, over another third, prevalent practice is considerably below the desired standard and could lead to the destruction of the forests. These figures, of course, are subject to reservations similar to those mentioned above in relation to working plans. The two sets of data are, in any case, interdependent. The establishment of a working plan implies the adoption of improved silvicultural practice, though of course a high standard of silvicultural treatment may precede the establishment of a working plan, as the examples in Table 13 show.

Rational management, to which the silvicultural system in force is closely tied, aims at establishing in the shortest possible time stands capable of producing the maximum possible volume of roundwood on a sustained basis. In Europe, it is possible to distinguish three different forest types: high forest, coppice with standards, and coppice. Coppice, entirely composed of stool-shoots or root-suckers of broadleaved species, yields mainly fuelwood and wood for charcoal burning. Coppice with standards, mostly with hardwoods in the upper storey, yields a low percentage of industrial wood. The highest yield of industrial wood comes from the high forest, entirely composed of trees of seedling origin. To raise the yield of industrial wood, the trend in silviculture is to convert the coppice, either directly by replanting or indirectly by selective cutting. Of the European forests in use reported on

[5] Defined as follows: *Good cutting*: fellings are carried out in conformity with the requirements of good silviculture; adequate planting, tending, thinnings, protection from fires and control of grazing are undertaken. *Fair cutting*: same criteria as good cutting, but planting, thinnings, etc. are not undertaken on an adequate scale. *Poor and destructive cutting*: fellings are neither carried out in conformity with the requirements of good silviculture nor is any planting, thinning or protection against grazing and fires undertaken.

TABLE 13. – CUTTING PRACTICES IN SELECTED COUNTRIES

Country	Percentage of forests in use covered by working plans	Percentage of forests in use subject to cutting practices described as		
		Good	Fair	Poor and destructive
Denmark	76	87	13	—
Western Germany	67	85	10	5
Sweden	60	90	10	—
Switzerland	71	90	10	—
Argentina	13	13	50	37
Brazil	1	10	20	70
Chile	—	5	5	90
Gold Coast	4	3	22	75
Peru	—	—	90	10
Philippines	1	—	30	70
Spain	6	15	70	15

— Nil.

in the inventory (85 percent of the total), 86 million hectares (or 79 percent) were under high forest, 8 million hectares (or 7 percent) under coppice with standards, and 15 million hectares (or 14 percent) under coppice. The latter two systems were most extensive, and sometimes dominant, in southern Europe, as is shown in Table 14.

TABLE 14. – SILVICULTURAL SYSTEMS IN SOUTHERN EUROPE

Country	Percentage of forests in use under different silvicultural systems		
	High forest	Coppice with standards	Coppice
Bulgaria	41	(.....	.....59)
France	43	31	26
Greece	42	40	18
Italy	39	21	40
Spain	64	14	22
Yugoslavia	64	—	36

— Nil.

Growing stock in forests in use

Information reported relating to the volume of standing timber in forests in use is summarized in Table 15.

For two important regions, North America and the U.S.S.R., the standing timber data do not relate only to forests in use. On the other hand not all the forests in use are covered by the data reported for other regions; coverage in Latin America, for example, is less than one-fourth. Table 15 therefore, does not give a meaningful picture of the real distribution of growing stock, although it includes information relating to about 81 percent of the world's forests in use.

TABLE 15. – GROWING STOCK IN FORESTS IN [illegible]

Region	Degree of response [a]	Growing stock (in million cubic meters with bark)			[illegible]		
		Total	Coniferous	Non-coniferous	Total	Coniferous	Non-coniferous
Europe	80	7 700	5 000	2 700	74	77	70
U.S.S.R. [b]	100	58 700	50 000	8 700	93	102	64
North America [c]	100	23 000	16 500	6 500	70	80	54
Latin America	23	2 700	200	2 500	129	272	124
Africa	69	5 900	100	5 800	74	41	75
Asia	68	12 500	3 800	8 700	89	120	80
Pacific Area	95	900	200	700	56	74	53

[a] Areas of forests in use in each region for which growing stock data were furnished, divided by total area of forests in use, expressed as a percentage.
[b] All forests.
[c] All accessible productive forests for Alaska and Canada, all productive accessible and inaccessible forests for the U.S.A.

If we assume that in each region the forests reported, whether more or less extensive than the forests in use, are representative [6] from the point of view of growing stock per hectare in both coniferous and broadleaved forests, then it may be estimated that total growing stock in all the world's forests in use amounts to about 96,000 million cubic meters (with bark), of which 59 percent consists of coniferous species. Over all the world's exploited forests, standing timber per hectare averages 95 cubic meters for coniferous forests and 75 cubic meters for broadleaved forests, a world average for all species of 85 cubic meters per hectare. Details of these estimates are given in a table appended to this article.

Though the growing stock figures in each region are not, for the reasons explained, comparable, some tentative conclusions may be drawn from the figures of growing stock per hectare. Nowhere does this exceed 100 cubic meters save in Latin America, and for this region the reported figures may well be unrepresentative. In general, the coniferous forests are denser than the broadleaved stands, and contain more timber per hectare. Africa, where conifers occupy mainly dry regions and bear little timber per hectare, presents the only exception. The high figure for the U.S.S.R., as compared with Europe and North America, derives from the fact that the forests of the Soviet Union contain a very high proportion of trees which are mature or nearing maturity.

Growing stock per hectare is a function of silvicultural treatment and age distribution, but above all of climate. In the tropical rain forests (e. g. Belgian Congo, Madagascar, French Equatorial Africa) it may reach 400 cubic meters; in temperate zones (Switzerland, Austria, Chile) 200 cubic meters is not uncommon: 50 to 60 cubic meters per hectare is typical for countries like Finland, Norway and Canada; in the savanna forests of Central Africa the figure may fall as low as 20 to 30 cubic meters.

[6] i. e. where coverage was high. Where coverage was low, and the reported data clearly unrepresentative, other assumptions were made.

Finally, it is perhaps worth recalling the warning given at the beginning of this article concerning standing timber data. Apart from the deficiencies in geographical coverage just referred to, there are wide differences in treatment, e. g. concerning how much of the tree is included. Even more serious is the fact that many countries include only commercial species in their estimates: this accounts for the low figures of growing stock per hectare reported by Bechuanaland (2 cubic meters), Northern Rhodesia (12), Tanganyika (14) and Sierra Leone (27). In all these cases the reported figures represent but a fraction of the actual growing stock.

Growth and allowable cut in forests in use

Table 16 summarizes for the different regions the data reported by countries relating to gross increment.

TABLE 16. – ANNUAL GROSS INCREMENT IN FORESTS IN USE

Region	Degree of response [a]	Gross increment (in million cubic meters with bark)			Gross increment per hectare (in cubic meters with bark)		
		Total	Conifers	Non-conifers	Total	Conifers	Non-conifers
Europe	100	284	183	101	2.5	2.5	2.4
U.S.S.R. [b]	100	750	590	160	1.2	1.2	1.2
North America [c]	100	536	300	236	1.8	1.8	1.9
Latin America	20	53	5	48	3.1	6.4	2.9
Africa	20	56	4	52	2.4	2.0	2.5
Asia	46	125	42	83	1.4	1.9	1.2
Pacific Area	88	19	2	17	1.3	1.8	1.2

[a] Area of forests in use for which data for increment were reported, divided by total area of forests in use for the region, expressed as a percentage.
[b] All forests.
[c] All accessible productive forests for Alaska and Canada, all commercial forests for the United States; figure for U.S.A. excludes natural losses caused by "normal" mortality.

The reported data related to about three-quarters of the world's exploited forests. Coverage is complete for the Northern Hemisphere, adequate for Oceania, fair for Asia but so small as to render conclusions uncertain for both Africa and Latin America. Moreover, as was the case for growing stock, the figures reported for North America and the U.S.S.R. do not relate merely to the forests in use. Thus not only does Table 16 fail to reflect the real distribution of annual growth in the world's exploited forests; but any conclusions about growth per hectare must be highly tentative.

An attempt has been made to estimate, on the basis of the data available, gross increment in exploited forests for the world as a whole. This calculation, of which details are given in Appendix II, suggests that gross increment is probably around 2,300 million cubic meters, of which 1,000 million cubic meters, or 46 percent, consist of coniferous species. Growth per hectare is probably around 1.8 cubic meters for coniferous and 2.4 for broadleaved species, averaging 2.1 cubic meters for all species over the world as a whole.

Net annual growth equals gross increment less natural losses, i. e. the volume of timber rendered unusable annually by fire, insect pests, tree diseases, snow, avalanches, wind storms, etc. The report on the 1947 inventory tentatively estimated natural losses in the world's coniferous forests at about 10 percent of gross increment. The information submitted in the present inventory is summarized in Table 17.

TABLE 17. GROSS INCREMENT, NATURAL LOSSES AND NET GROWTH

Region	Degree of response [a]	Gross increment (million m³)	Natural losses		Net growth (million m³)	Cubic meters per hectare	
			Total (million m³)	As percentage of gross increment		Gross increment	Net growth
Europe	89	284	13	4.6	271	2.5	2.4
North America [b]	100	536	90	16.8	446	1.8	1.5
Africa	16	19	1	6.8	18	1.1	1.0
Asia	46	125	14	10.9	111	1.3	1.2
Pacific Area	88	19	13	69.6	6	1.3	0.4

[a] Area of forests in use for which data for gross increment, natural losses and net growth were reported, divided by total area of forests in use for the region, expressed as a percentage.
[b] See note [c] on Table 16.

The inadequate degree of response (and in certain cases the unrepresentative nature of the data reported) preclude any world estimates. In fact no estimate of natural losses makes sense unless it relates to an average over an adequate period, since several elements are "accidental" (fires, epidemics, severe gales) and can vary considerably from year to year. Thus the high figure for the Pacific region is unrepresentative since it reflects the high incidence of forests fires in the year of the Australian inventory, 1950.

The concept of natural losses as the difference between gross and net increment has an important place in theory; its definition and its measurement present serious problems. One thing, and one thing only, emerges clearly from the data reported; in Europe, where climatic conditions are favorable and where the standard of forest management is high, natural losses amount to about 5 percent of gross increment. For all other regions the state of knowledge concerning natural losses is so rudimentary, or the qualifications attached to the definition of natural losses so serious, that it would be rash to draw any conclusions.

For this reason all the estimates of net growth included in Table 17 should be treated with considerable reserve, save perhaps that for Europe. Here net growth averages 2.4 cubic meters per hectare for conifers and slightly less for broadleaved species. Net growth varies not only with climate but with the age and species composition of the forest. It may range from less than 0.5 cubic meter per hectare in extreme latitudes (Alaska) or arid areas (Rhodesia) to 5 or more cubic meters where climate is favorable.

Sustained yield is one of the aims of a national forest policy; it finds its expression in the concept of allowable cut, which may, in the short term, be higher or lower than net increment, depending on age distribution,

species composition and growth. Only in a forest in equilibrium does allowable cut equal net growth. Allowable cut is a key figure for forest management and each individual working plan indicates the allowable cut for the forest which the plan covers. In the precise sense, allowable cut for a nation's forests is usually arrived at (by simple aggregation) for those forests covered by working plans; it will be recalled that only one-third of the world's exploited forests are managed in accordance with working plans. Nevertheless, each country aims at assessing the volume of roundwood which may be felled yearly in conformity with sustained yield principles. This figure, also termed "allowable cut," may be estimated by the government, by the forest authorities or by research institutes. Clearly it acn only be computed if certain fundamental information relating to the nation's forests is available. The following table summarizing information reported under this heading thus essentially depicts the progress made in forest statistics and administration to date:

TABLE 18. – NET GROWTH AND ALLOWABLE CUT IN FORESTS IN USE

Region	Degree of responses[a]	Total in million cubic meters		Per hectare in cubic meters	
		Net growth	Allowable cut	Net growth	Allowable cut
Europe	87	269	244	2.4	2.2
Africa	8	13	9	1.4	1.0
Asia	38	74	73	1.0	1.0

[a] Area of forests in use for which data for net growth and allowable cut were reported, divided by total area of forests in use for the region, expressed as a percentage.

This key figure for forest policy exists for only about 18 percent of the total area of the world's exploited forests, and only in Europe is it possible to arrive at an adequate comparison of net growth and allowable cut. The fact that the latter is but nine-tenths of the former indicates that the composition of European forests, in the view of European foresters, does not warrant fellings up to the limit of net growth. In fact with one exception allowable cut falls short of net increment in all European countries, and considerations other than those of forest conservation were decisive in the exceptional case — Yugoslavia.

In the reporting Asian countries, allowable cut is on the whole around the same figure as net growth. In the reporting African countries allowable cut is on average about two-thirds of net growth, though the proportion falls to half in the Union of South Africa, with a preponderance of young stands.

Fellings and removals

The paucity of the information available relating to net growth and allowable cut in the world's forests in use means that for only a small proportion of the world's exploited forests can these key figures be related to fellings. The response in fact covers most of Europe's, a third of Asia's, and a fraction of Africa's, forests in use. For a comparison of fellings and net growth only, the situation is only slightly better, for although this adds an adequate coverage in respect of the [illegible] area, it will be recalled that the net growth figure rec[illegible] for this region is not representative.

TABLE 19. – NET GROWTH, ALLOWABLE CUT AND FELLINGS IN FORESTS IN USE

Region	Degree of response[a]	Net growth	Allowable cut	Fellings	Degree of response[b]	Net growth	Fellings
		(in million cubic meters without bark)				(in million cubic meters without bark)	
Europe	75	210	191	224	75	210	224
Africa	5	8	5	5	10	11	9
Asia	36	63	63	77	36	64	78
Pacific Area	..	..	..	..	92	9	15

[a], [b] Area of forests in use where *a*) net growth, allowable cut and fellings, and *b*) net growth and fellings, were reported, divided by total area of forests in use in each region, expressed as a percentage.
... Not available.

Table 19 shows the extent of overcutting in the forests of European reporting countries; fellings exceed net growth by 6 percent and allowable cut by 17 percent. The case of Yugoslavia has already been mentioned, but this is by no means the only European country where the figure laid down for sustained yield management is being exceeded. In other regions the exclusion of non-commercial species and the inclusion of brushlands as forest confuse the picture, but the reports of individual countries (Burma, Chile, Ethiopia, Turkey, Japan, for example) make it clear that overcutting is far from rare.

Information relating to logging and floating losses is limited and of uncertain accuracy. Table 20 summarizes the data reported for each region; it covers less than two-fifths of the world's exploited forests.

TABLE 20. – FELLINGS AND REMOVALS IN FORESTS IN USE

Region	Degree of responses[a]	Total fellings (in million m³) [b]	Logging and floating losses		Removals	
			Total (in million m³) [b]	As percentage of fellings	Total (in million m³) [b]	Per hectare (m³) [b]
Europe	75	224	18	8	206	2.2
North America	78	288	..	..	288	2.0
Latin America	55	118	13	11	105	2.1
Africa	11	22	*	1	22	1.8
Asia	50	103	1	1	102	1.2
Pacific Area	93	15	1	4	14	0.9

[a] Area of forests in use where fellings and losses were reported divided by total area of forests in use in each region, expressed as a percentage.
[b] Cubic meters without bark.
* Negligible.
... Not available.

The figures would suggest that for the world as a whole logging and floating losses amount to about 4 percent of fellings. This, however, is an unrealistic figure since it is hardly likely that such losses in Africa

and Asia are lower than the 8 percent recorded for Europe, where the forests are served by a highly developed network of communications. No doubt inadequate felling statistics and the exclusion of non-commercial species are responsible for the low figures reported; actual losses in the Southern Hemisphere may well reach or exceed 10 percent. Individual country reports indicated losses exceeding one-fourth of total fellings in Ceylon, Chile and Madagascar, one-fifth in Paraguay and South Korea, and one-tenth in Brazil, Ecuador, France, New Zealand, Spain, Syria and Viet-Nam.

FAO collects and publishes each year figures of removals in forests in use from all its member countries and their dependencies.[7] These data, averaged over recent years (in most cases, 1950-52), have been supplemented by such other information as was obtainable and are presented in Table 21.

TABLE 21. – REMOVALS IN THE WORLD'S FORESTS IN USE, AVERAGE 1950-52
(million cubic meters, without bark)

Region	Removals		Industrial wood		Fuelwood		Industrial wood as % of removals	Removals per inhabitant (in m³)
	Total	of which conifers	Total	of which conifers	Total	of which conifers		
Europe	268	158	158	129	110	29	59	0.69
U.S.S.R.	335	285	195	165	140	110	58	1.74
North America	375	277	309	250	66	27	82	2.22
Latin America	148	9	20	8	128	1	14	0.90
Africa	96	2	9	2	87	*	9	0.48
Asia	150	45	57	38	93	7	38	0.12
Pacific Area	15	4	11	4	4	*	73	1.15
WORLD TOTAL	1 387	780	759	596	628	174	55	0.57

* Negligible.

These figures exclude unrecorded removals and illicit fellings in those countries for which no official estimates have been made. Thus about 1,400 million cubic meters are removed annually from the world's exploited forests. The share of industrial wood, roughly half for the world as a whole, varies from region to region in accordance with the species distribution (a bigger proportion of conifers is used industrially) and with the wood fuel needs of the local populations. In countries well-endowed with forests, and where the population is thinly spread, most of the wood suitable only for fuel is left in the forest. In other parts of the world, where wood fuel is scarce and other fuels expensive or unobtainable, all the fuelwood is removed. Thus a high fuelwood percentage does not necessarily imply irrational exploitation.

For the world as a whole, removals average just over half a cubic meter per inhabitant annually. This again varies from region to region, and reflects, *inter alia*, the stage reached in the development of the wood-using industries and the scale of exports. Some of the higher figures recorded are 10 cubic meters in Finland, 6 in Canada and 3 in Norway, whilst in countries severely lacking in forests the figure falls to a very small fraction of a cubic meter.

[7] *Yearbook of Forest Products Statistics*; the seventh issue appeared in 1953.

Other roundwood supplies

The world's roundwood reserves are not limited to forest trees; they are supplemented by trees or groups of trees planted in parks and gardens, by trees planted separately, in rows or in clumps as windbreaks along rivers, canals and roads, by areas of fruit trees, poplar and other species planted on agricultural land to enhance the income obtained from the soil, by woodlands planted on irrigated land scattered throughout arid regions.

Roundwood supplies from trees outside the forest are mainly used as fuel for local consumption; sometimes they supply the woodworking industries with precious species not grown in the forest (fruit trees, for example, and especially cherry, apple and pear); occasionally they serve as an important source of constructional timber, veneer logs and pulpwood.

Statistics of trees outside the forest are almost always deficient. These trees normally belong to a multitude of small owners; they are usually outside the jurisdiction of the forest service and their felling is not controlled. Nevertheless, the data submitted by the 33 countries which were able to provide an estimate of roundwood supplies from this source suggest that the significance of this source of supply has in the past been underestimated.

In the reporting countries, about 33 million cubic meters of roundwood were derived from trees outside the forest, representing 14½ percent of all domestic roundwood supply. All but 8 percent of this wood was used as fuel, so that roundwood from this source accounted for 4½ percent and 26 percent of the total industrial wood and total fuelwood supplies respectively. These figures make it clear that trees outside the forest cannot be neglected when planning a forest policy based on a nation's total wood resources.

By way of example, relevant figures for certain European and Near Eastern countries are given in Table 22.

TABLE 22. SUPPLY OF ROUNDWOOD FOR NON-FORESTED AREAS

Country	Supply from non-forested areas			
	Total (in thousand cubic meters)	As percentage of total removals of		
		All roundwood	Industrial wood only	Fuelwood only
France	3 640	12	3	19
Great Britain	230	13	..	..
Italy	9 238	41	18	47
Jordan	2	5	40	.
Israel	1	10	17	..
Netherlands	158	20	20	20
Syria	1 585	38	66	38

... Not available.

In Italy and Syria, the forests furnish only three-fifths of the indigenous roundwood supply. In both France and Great Britain trees outside the forest account for one-eighth of total native supply. It is clear that future national forest inventories, especially in countries ill-endowed with forests, will have to take into consideration the need to assess more exactly the potential supply from non-forested areas.

Conclusions

The 1953 world forest inventory shows that the world's forests are potentially capable of furnishing a plentiful flow of forest products for a world population much higher than that of today. Of 3,900 million hectares of woodlands, less than a third are today exploited. Of the immense unexploited reserve of standing timber in the world today, over 600 million hectares are accessible at the present time.

The inventory emphasises once again the contrast between the world's exploited coniferous forests, where growth and drain roughly balance, and the under-exploited broadleaved forests in use. The three predominantly coniferous regions, Europe, the U.S.S.R. and North America, account for one-third of the world population and less than two-fifths of the world's woodlands; yet between them they account for 70 percent of the removals from the world's forests.

A fundamental question is whether natural losses and fellings exceed the rate at which wood is being produced. Are the forests being overcut? Here again, the present inventory does not admit of firm and precise answers. As a very rough estimate, based on reported removals and making various assumptions concerning bark proportion, logging and floating losses, natural losses and gross increment, we can perhaps say that in the world's 600 million hectares of exploited coniferous forests, growth and drain are just about in balance — at around 1,100 million cubic meters with bark. The tentative nature of this conclusion will be apparent from earlier references to the many deficiencies in the reported data. In the 500 million hectares of exploited broadleaved forests, gross increment may be reckoned at about 1,300 million cubic meters, of which perhaps three-quarters is drained off by fellings or natural losses. This under-exploitation derives largely from the fact that many of the species growing in the tropical and sub-tropical forests are not today marketed, and only a fraction of the non-commercial species is used as fuel.

Forests are renewable resources. Given skillful management, they can yield annual crops in perpetuity. On the other hand, these invaluable assets ca[illegible] easily be destroyed. And, as history has shown, re[illegible] misuse of the forests is not simply a matter of deple[illegible] the forest capital; the consequences for the climate, the soil and the water regime can be catastrophic. [illegible] over vast areas of the world forest management has not attained the stage of sustained yield. Even the basic classification of reserved forests has hardly started in some regions; the forest area covered by working plans is still relatively small, while there are very few countries indeed where the prevalent cutting practices do not leave much to be desired.

All the information sought in this second world forest inventory of FAO consisted of data which may be regarded as essential for the formulation of national forest policies. As compared with the response to the first enquiry, this inventory records encouraging, even striking, progress. Nevertheless, the material assembled does not yet enable us to build up a complete and comprehensive picture of the world's forest resources.

First because in spite of the considerable progress made in the direction of international comparability, national statistics still differ widely in scope, content and reliability. The basic distinction between accessible and inaccessible forests is neither universal nor uniform; nor is the division of accessible forests into forests in use and unexploited forests common to all countries; there are many different ways of calculating standing timber, growth and drain; recorded fellings often cover only a part of the forest crop.

Secondly, many countries do not as yet collect all the data necessary for the formulation of forest policy. In fact, the collection of many of these data, e. g. on growing stock, growth, drain and fellings, calls not only for a high degree of technical skill and the correct application of statistical methods, but also for a highly organized forest service, with arrangements for the local collection of statistics. Thus further advances depend on the wider adoption of a minimum statistical program, on progress towards agreed concepts and definitions, and on the establishment, or extension, of statistical services within the countries. Thus, while this inventory tells us a great deal, far more than has been known before, about the world's forests, it also represents a progress report which indicates the advances which have been made in recent years in forest consciousness, forest management and forest statistics.

The response to the 1953 inventory is, therefore, at once an encouragement and a challenge: an encouragement, since it demonstrates the important advances which have been made since the war; a challenge, since it emphasifies how much remains to be done if the world's forest resources are to be utilized rationally.

APPENDIX I — LAND CATEGORIES

Country	Forests: Accessible forests	Forests: Inaccessible forests	Forests: Total	Non-forested land: Agricultural land	Non-forested land: Brush and other land	Non-forested land: Total	Land area	Forests as percentage of land area: All forests	Forests as percentage of land area: Accessible forests	Forest area per caput: All forests	Forest area per caput: Accessible forests
	(.....1 000 hectares.....)							(.. Percent ..)		(.. Hectares ..)	
Total	1 773 700	2 141 600	3 915 300	2 959 400	6 377 100	9 336 500	13251 800	29.5	13.4	1.6	0.7
Europe	132 600	3 100	135 700	241 000	102 300	343 300	479 000	28.3	27.7	0.3	0.3
Albania	*1 130*	—	*1 130*	1 205	*405*	1 610	2 740	*41.2*	*41.2*	*0.9*	*0.9*
Austria	[a]2 500	[b]656	3 156	4 322	879	5 201	8 357	37.8	29.9	0.5	0.4
Belgium	601	—	601	1 826	597	2 423	3 024	19.9	19.9	0.07	0.07
Bulgaria [c]	*3 700*	—	*3 700*	*6 725*	*659*	*7 384*	11 084	*33.4*	*33.4*	*0.5*	*0.5*
Czechoslovakia	4 023	—	4 023	7 539	955	8 494	12 517	32.1	32.1	0.3	0.3
Finland	[a]20 700	[b]960	21 660	3 430	5 460	8 890	30 550	70.9	67.8	5.3	5.1
France [d]	11 407	—	11 407	33 486	10 157	43 643	55 050	20.7	20.7	0.3	0.3
Germany, Western	[e]6 732	—	6 732	14 195	3 056	17 251	23 983	28.1	28.1	0.14	0.14
Germany, Eastern [c]	*2 749*	—	*2 749*	6 378	*1 591*	*7 969*	10 718	*25.6*	*25.6*	0.16	0.16
Greece	1 850	150	2 000	9 020	2 136	11 156	13 156	15.2	14.1	0.3	0.2
Italy	5 648		5 648	20 606	3 125	23 731	29 379	19.2	19.2	0.12	0.12
Netherlands	250	—	250	2 513	541	3 054	3 304	7.6	7.6	0.02	0.02
Norway	[f]6 700	800	7 500	1 050	22 350	23 400	30 900	24.3	21.7	2.3	2.0
Poland [c]	*7 503*	—	*7 503*	20 864	*2 806*	23 670	31 173	*24.1*	*24.1*	*0.3*	*0.3*
Portugal	2 467	—	2 467	3 420	2 884	6 304	8 771	28.1	28.1	0.3	0.3
Romania [c]	(... *6 326*	.....)	*6 326*	12 700	*4 712*	17 412	23 738	26.6	26.6	0.4	0.4
Spain [g]	12 500	50	12 550	33 100	4 200	37 300	49 850	25.2	25.1	0.4	0.4
Sweden	22 980	—	22 980	5 680	12 400	18 080	41 060	56.0	56.0	3.2	3.2
United Kingdom	1 561	—	1 561	19 502	3 039	22 541	24 102	6.5	6.5	0.03	0.03
Yugoslavia	8 395	350	8 745	13 913	1 077	14 990	23 735	36.8	35.4	0.5	0.5
Others	2 859	100	2 959	19 526	19 314	38 840	41 799	7.1	6.8	0.11	0.10
U.S.S.R.	*425 000*	*317 600*	742 600	349 000	1 097 700	1 446 700	2 189 300	*33.9*	*19.4*	3.5	2.2
North and Central America	358 700	363 200	721 900	595 000	990 500	1 585 500	2 307 400	31.3	15.5	3.4	1.7
Alaska	[a]11 332	[b]50 588	61 920	15 783	70 012	85 795	147 715	41.9	7.7	495.4	90.7
Canada [h]	[a]130 168	[b]211 795	341 963	79 310	476 468	555 778	897 741	38.1	14.5	23.7	9.0
Costa Rica	2 350	1 575	3 925	880	210	1 090	5 015	78.3	46.9	4.6	2.8
Cuba [c]	[a,i]2 585	[b,i]878	3 463	5 867	2 122	7 989	11 452	30.2	22.6	0.7	0.5
Dominican Republic [c]	[j]3 007	[k]431	3 438	1 260	309	1 569	5 007	68.7	60.1	1.6	1.4
El Salvador	479	242	721	712	526	1 238	1 959	36.8	24.5	0.4	0.2
Guatemala	3 068	3 500	6 568	1 998	2 073	4 071	10 639	61.7	28.8	2.3	1.1
Honduras [c]	*3 873*	*1 000*	*4 873*	2 770	3 877	6 647	11 520	42.3	*33.6*	3.3	*2.6*
Mexico [c]	24 565	1 293	25 856	23 400	147 784	171 184	197 040	13.1	12.5	1.0	0.9
Nicaragua	1 502	4 948	6 450	855	6 395	7 250	13 700	47.1	11.0	5.9	1.4
Panama [c]	1 181	4 089	5 270	1 002	1 275	2 277	7 547	69.8	15.6	7.2	1.6
United States	[l]170 780	[k]81 750	252 530	458 930	59 490	518 420	770 950	32.8	22.2	1.8	1.2
Others	3 804	1 113	4 917	2 300	219 958	222 258	227 175	2.2	1.7	0.5	0.4
South America	296 200	564 800	861 000	322 500	567 000	889 500	1 750 500	49.2	16.9	7.4	2.5
Argentina [c]	60 000	10 000	70 000	145 150	62 680	207 830	277 830	25.2	21.6	3.9	3.3
Bolivia [c]	*6 000*	*41 000*	47 000	340	59 570	59 910	106 910	44.0	*5.6*	14.5	*1.9*
Brazil	120 048	360 147	480 195	51 347	314 878	366 225	846 420	56.7	14.2	8.6	2.2
Chile [c]	6 895	9 465	16 360	12 700	45 117	57 817	74 177	22.1	9.3	2.8	1.2
Colombia	62 000	7 000	69 000	39 416	3 700	43 116	112 116	61.5	55.3	5.7	5.2
Ecuador [c]	2 500	9 500	12 000	4 700	10 800	15 500	27 500	43.6	9.1	3.6	0.7
Paraguay [c]	6 272	14 634	20 906	17 035	774	17 809	38 715	54.0	16.2	15.3	4.3
Peru	15 000	55 000	70 000	16 583	26 322	42 905	112 905	62.0	13.3	7.9	1.7
Uruguay	486		486	16 008	782	16 790	17 276	2.8	2.8	0.2	0.2
Venezuela [c]	*12 000*	*24 500*	*36 500*	16 500	*36 890*	53 390	89 890	*40.6*	*13.3*	*7.1*	*2.3*
Others	5 000	33 568	38 568	2 742	5 412	8 154	46 722	82.5	10.7	65.6	8.5
Africa	282 500	519 100	801 600	664 200	1 504 500	2 168 700	2 970 300	27.0	9.5	4.0	1.4
Algeria [c]	[a]1 635	[b]1 435	3 070	47 049	170 367	217 416	220 486	1.4	0.7	0.3	0.18
Anglo-Egyptian Sudan	42 130	51 800	94 110	1 555	141 965	143 520	237 630	39.6	17.8	10.7	4.8
Angola [c]	*33 200*	*10 000*	*43 200*	*29 900*	*51 570*	*81 470*	*124 670*	*34.7*	*26.6*	*16.5*	*12.7*
Bechuanaland	67 887		67 887	138	1 675	1 813	69 700	97.4	97.4	232.5	232.5
Belgian Congo	15 000	85 393	100 393	51 310	69 690	121 000	221 393	45.3	6.8	8.5	1.3
British Somaliland	6 000	2 029	8 029	2 072	6 734	8 806	16 835	47.7	35.6	16.1	12.0

APPENDIX I — LAND CATEGORIES

Country	Forests			Non-forested land			Land area	Forests as percentage of land area		Forest area per caput	
	Accessible forests	Inaccessible forests	Total	Agricultural land	Brush and other land	Total		All forests	Accessible forests	All forests	Accessible forests
	(..... 1 000 hectares						.....)	(.. Percent	..)	(.. Hectares	..)
Ethiopia	200	7 200	7 400	38 800	58 750	97 550	104 950	7.1	0.2	0.5	0.0
French Cameroons	4 400	18 490	22 890	1 200	18 610	19 810	42 700	53.6	10.3	7.3	1.41
French Equat. Africa	27 047	125 373	152 420	67 000	30 000	97 000	249 420	61.1	10.8	34.3	6.1
French Morocco	[a]2 450	[b]1 500	3 950	11 500	23 540	35 040	38 990	10.1	6.3	0.5	0.3
French Togoland	580	1 660	2 240	580	2 680	3 260	5 500	40.7	10.5	2.2	0.6
French West Africa	14 000	96 000	110 000	35 000	322 000	357 000	467 000	23.6	3.0	6.3	0.8
Gold Coast [c,d]	4 497	10 070	14 567	8 559	657	9 216	23 783	61.2	18.9	3.6	1.1
Kenya	522	769	1 291	13 600	42 019	55 619	56 910	2.3	0.9	0.2	0.09
Liberia	[m]800	8 100	8 900	300	1 700	2 000	10 900	81.7	7.3	5.4	0.5
Madagascar	2 500	3 500	6 000	40 270	13 200	53 470	59 470	10.1	4.2	1.4	0.6
Nigeria [n]	1 135	29 800	30 935	22 640	42 320	64 960	95 895	32.3	1.2	1.0	0.04
Northern Rhodesia [c]	3 700	33 400	37 100	30 300	6 020	36 320	73 420	50.5	5.0	18.7	1.9
Nyasaland [c]	1 760	—	1 760	3 420	4 372	7 792	9 552	18.4	18.4	0.7	0.7
Somalia	[j]64	[k]7 078	7 142	33 635	9 023	42 658	49 800	14.3	0.1	5.7	0.05
Southern Rhodesia	5 992	18 939	24 931	5 595	8 384	13 979	38 910	64.1	15.4	11.2	2.7
South West Africa	120	5 046	5 176	51 191	25 824	77 015	82 191	6.3	0.2	13.8	0.3
Spanish Guinea [o]	1 405	190	1 595	325	640	965	2 560	62.3	54.9	7.8	6.9
Tanganyika	36 340	—	36 340	17 612	34 809	52 421	88 761	40.9	40.9	4.6	4.6
Tunisia [o]	*700*	*200*	*900*	3 943	10 740	14 683	15 583	*5.8*	*4.5*	*0.3*	*0.2*
Uganda	1 620	—	1 620	2 760	16 410	19 170	20 790	7.8	7.8	0.3	0.3
Union of South Africa	1 200	—	1 200	6 970	114 255	121 225	122 425	1.0	1.0	0.1	0.1
Others	5 447	1 082	6 529	136 967	276 546	413 513	420 042	1.6	1.3	0.16	0.14
Asia	259 200	307 600	566 800	751 300	1 382 400	2 133 700	2 700 500	21.0	9.6	0.4	0.2
British North Borneo [c]	3 600	2 600	6 200	260	1 140	1 400	7 600	81.6	47.4	18.4	10.7
Burma	25 278	13 704	38 982	8 806	19 903	28 709	67 691	57.6	37.3	2.0	1.3
Cambodia	6 000	2 800	8 800	1 200	7 400	8 600	17 400	50.6	34.5	2.3	1.6
Ceylon	1 118	2 414	3 532	1 411	1 412	2 823	6 355	55.6	17.6	0.4	0.14
China	[a]28 100	[b]52 420	80 520	287 350	572 960	860 310	940 830	8.6	3.0	0.18	0.06
India	[p]48 930	22 049	70 979	185 043	[c,q]72 102	257 145	328 124	21.6	14.9	0.2	0.14
Indonesia [c]	11 000	110 000	121 000	11 000	58 435	69 435	190 435	63.5	5.8	1.6	0.14
Iran [c]	*16 000*	*3 000*	*19 000*	26 760	117 840	144 600	163 600	*11.6*	*9.8*	*1.0*	*0.9*
Iraq [c]	895	645	1 540	6 338	36 566	42 904	44 444	3.5	2.0	0.3	0.19
Japan [c]	21 780	837	22 617	4 766	9 232	13 998	36 615	61.8	59.5	0.3	0.3
Korea, South	5 775	642	6 417	2 241	[c]125	2 366	8 783	73.1	65.8	0.3	0.3
Laos [c]	[r]4 000	[s]11 000	15 000	2 000	6 600	8 600	23 600	63.6	16.9	12.8	3.4
Malaya	5 165	5 220	10 385	1 940	800	2 740	13 125	79.1	39.4	1.9	0.9
New Guinea (Neth.) [c]	*1 000*	*30 000*	*31 000*	(.....	*10 278*)	*10.278*	41 278	*75.1*	*2.4*	*44.3*	*1.4*
Pakistan [c]	*2 300*	*400*	*2 700*	*25 000*	*69 936*	94 936	97 636	*2.8*	*2.4*	*0.04*	*0.03*
Philippines	10 738	5 580	16 318	8 180	5 243	13 423	29 741	54.9	36.1	0.8	0.5
Sarawak	8 820	—	8 820	2 905	405	3 310	12 130	72.7	72.7	15.4	15.4
Syria	444	5	449	6 591	11 344	17 935	18 384	2.4	2.4	0.13	0.13
Taiwan [c]	1 788	497	2 285	829	482	1 311	3 596	63.5	49.7	0.3	0.2
Thailand	15 715	16 414	32 129	7 793	1 707	9 500	41 629	77.2	37.8	1.6	0.8
Turkey	10 284	300	10 584	17 175	49 022	66 197	76 781	13.8	13.4	0.5	0.5
Viet-Nam	11 950	1 550	13 500	7 270	11 411	18 681	32 181	42.0	37.1	0.5	0.5
Others	18 487	25 583	44 070	136 421	318 076	454 497	498 567	8.8	3.7	0.8	0.4
Pacific Area	19 500	66 200	85 700	36 400	732 700	769 100	854 800	10.0	2.3	6.7	1.5
Australia [c]	15 050	[t]26 325	41 375	24 040	705 000	729 040	770 415	5.4	2.0	5.1	1.8
Br. Solomon Islands	20	2 640	2 660	50	170	220	2 880	92.4	0.7	26.1	0.2
Fiji [c]	140	815	955	873	—	873	1 828	52.2	7.7	3.1	0.5
Hawaii	450	325	775	380	510	890	1 665	46.5	27.0	1.6	0.9
New Guinea (Austr.) [c]	*3 000*	*30 000*	33 000	2 440	11 960	14 400	47 400	69.6	*6.3*	22.4	*2.0*
New Zealand	685	5 745	6 430	7 785	12 185	19 970	26 400	24.4	2.6	3.6	0.4
Western Samoa	65	120	185	49	59	108	293	63.1	22.2	2.2	0.8
Others	111	175	286	803	2 845	3 648	3 934	7.3	2.8	0.7	0.3

NOTE: Unofficial figures are indicated in italics.

[a] Accessible productive forest only. — [b] Includes accessible unproductive forest. — [c] Figures include areas of rivers and lakes. — [d] Figures include areas of rivers but not lakes. — [e] Excludes 122,000 hectares of open areas within the forests. — [f] Includes 1,400,000 hectares of inferior broadleaved forests yielding only fuelwood, occurring above the coniferous tree line. — [g] Includes Canary and Balearic Islands. [h] Excludes Labrador. — [i] Includes brushlands. — [j] All productive forests, accessible and inaccessible. — [k] All unproductive forests, accessible and inaccessible. — [l] Includes British Togoland. — [m] Includes rubber plantations. — [n] Includes British Cameroons. — [o] Continental Spanish Guinea only. — [p] Reported as exploitable and potentially exploitable forest. — [q] Includes 24 million hectares for which details of land categories are not available. — [r] Commercially exploited forests only. — [s] Forests not yet exploited commercially. — [t] Includes small areas of accessible forests of poor quality.

APPENDIX II — SOME WORLD ESTIMATES

In the following four tables, an attempt has been made to estimate world totals for some of the more important elements of the inventory. These estimates, since they are based mainly on reported data, encompass all those defects in the information submitted which have already been referred to. Further possibilities of error are introduced in grossing up figures for those countries and regions where response was low, although some adjustments have been made in cases where the reported data were clearly unrepresentative. Nevertheless it is believed that these figures will be of interest, as indicating orders of magnitude.

TABLE A. – DISTRIBUTION OF THE WORLD'S FORESTS
Secretariat Estimates

Region	Total forested area	Accessibility		Composition		Utilization		Forests as % of land area	Forest area per inhabitant
		Inaccessible forests	Accessible forests	Conifers	Non-conifers	Forests in use	Unexploited forests		
	(.....Million hectares.....)							(..%..)	(Hectares)
Europe	136	3	133	79	57	130	6	28.4	0.3
U.S.S.R.	743	318	425	583	106	350	393	33.9	3.8
North America	656	344	312	463	193	220	436	36.1	4.1
Latin America	927	584	343	30	897	90	837	41.3	5.5
Africa	801	519	282	5	796	115	686	27.0	3.9
Asia	567	308	259	120	447	205	362	21.0	0.4
Pacific Area	85	65	20	8	77	17	68	9.9	6.6
WORLD TOTAL	3 915	2 141	1 774	1 288	2 627	1 127	2 788	29.5	1.6

TABLE B. – GROWING STOCK IN THE WORLD'S FORESTS IN USE
Secretariat Estimates

Region	Area of forests in use (million hectares)			Estimated growing stock per hectare (cubic meters with bark)		Total growing stock (million cubic meters with bark)		
	Conifers	Non-conifers	All species	Conifers	Non-conifers	Conifers	Non-conifers	All species
Europe	75	55	130	80	70	6 000	3 800	9 800
U.S.S.R.	300	50	350	100	60	30 000	3 000	33 000
North America	170	50	220	80	60	13 600	3 000	16 600
Latin America	10	80	90	120	100	1 200	8 000	9 200
Africa	2	113	115	40	70	100	7 900	8 000
Asia	50	155	205	120	80	6 000	12 400	18 400
Pacific Area	2	15	17	75	55	200	800	1 000
WORLD TOTAL	609	518	1 127	95	75	57 100	38 900	96 000

TABLE C. – REMOVALS AND GROSS INCREMENT IN THE WORLD'S FORESTS IN USE
Secretariat Estimates

Region	Total removals (in million cubic meters *without* bark)			Annual gross increment per hectare (in cubic meters *with* bark) [a]		Total gross increment (in million cubic meters *with* bark) [a]		
	Conifers	Non Conifers	All species	Conifers	Non-conifers	Conifers	Non-conifers	All species
Europe	158	110	268	2.5	2.4	190	130	320
U.S.S.R.	285	50	335	1.3	1.3	390	65	455
North America	277	98	375	2.1	2.1	360	110	470
Latin America	9	139	148	3.0	3.0	30	240	270
Africa	2	94	96	2.0	2.5	4	280	284
Asia	45	105	150	2.0	2.7	100	420	520
Pacific Area	4	11	15	2.0	1.3	4	20	24
WORLD TOTAL	780	607	1 387	1.8	2.4	1 078	1 265	2 343

[a] Corresponding areas see Table B.

NOTE: Removals and gross increment are included in the same table for reasons of space. They are not, of course, comparable. Since they are on a different bark basis, the differences afford no indication of the sum of natural, logging and floating losses.

TABLE D. – PERCENTAGE DISTRIBUTION BY REGIONS OF FORESTS, GROWING STOCK, GROWTH AND REMOVALS
Secretariat Estimates

Region	Forested area %	Accessible forests %	Forests in use %	Growing stock %	Gross increment %	Removals %
Europe	3	7	12	10	14	19
U.S.S.R.	19	24	31	35	19	24
North America	17	18	19	17	20	27
SUB-TOTAL A	39	49	62	62	53	70
Latin America	24	19	8	10	12	11
Africa	20	16	10	8	12	7
Asia	15	15	18	19	22	11
Pacific Area	2	1	2	1	1	1
SUB-TOTAL B	61	51	38	38	47	30

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